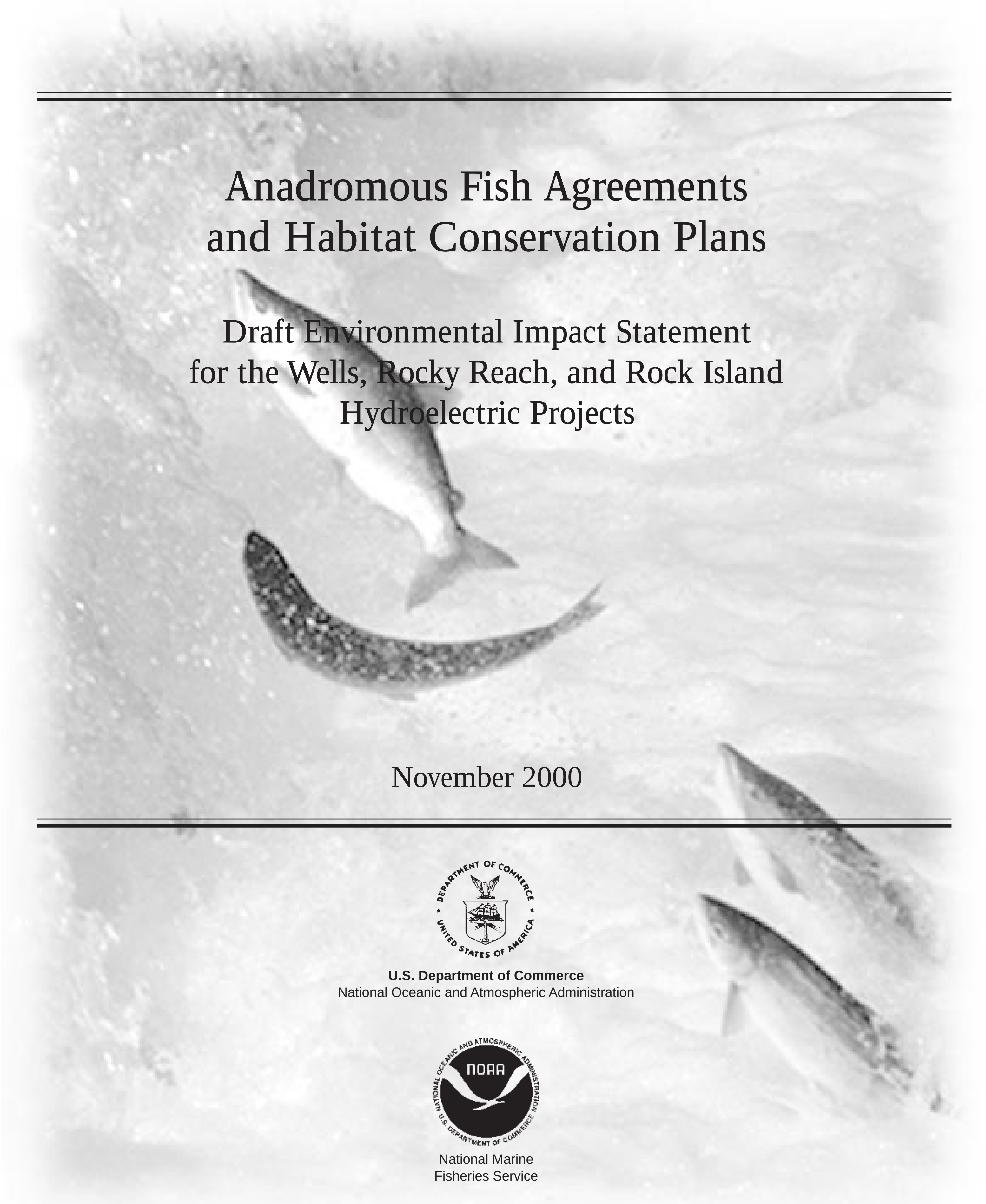

Anadromous Fish Agreements and Habitat Conservation Plans

Draft Environmental Impact Statement for the Wells, Rocky Reach, and Rock Island Hydroelectric Projects

November 2000

U.S. Department of Commerce
National Oceanic and Atmospheric Administration

National Marine
Fisheries Service

ACRONYMS

ALCOA	Aluminum Company of America
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BOR	Bureau of Reclamation
BP	Before Present
BPA	Bonneville Power Administration
CFR	Code of Federal Regulations
cfs	cubic feet per second
EIS	environmental impact statement
FERC	Federal Energy Regulatory Commission
HCP	habitat conservation plan
JARPA	Joint Aquatic Resource Permit Application
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NTU	nephelometric turbidity unit
ODFW	Oregon Department of Fish & Wildlife
PIT	passive integrated transponder
PUD	public utility district
RCW	Regulatory Code of Washington
ROD	Record of Decision
SEPA	State Environmental Policy Act
USDOE	U.S. Department of Energy
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
WDFW	Washington Department of Fish & Wildlife
WDOE	Washington Department of Ecology
WRIA	Watershed Resource Inventory Area

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Anadromous Fish Agreements and Habitat Conservation Plans for the Wells, Rocky Reach, and Rock Island Hydroelectric Projects

Draft Environmental Impact Statement

Submitted pursuant to
the National Environmental Policy Act [42 U.S.C. 4322(2)(c)]

by the

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE

in cooperation with

PUBLIC UTILITY DISTRICT NO. 1 OF DOUGLAS COUNTY
PUBLIC UTILITY DISTRICT NO. 1 OF CHELAN COUNTY
FEDERAL ENERGY REGULATORY COMMISSION

Draft Environmental Impact Statement

Anadromous Fish Agreements and Habitat Conservation Plans for the Wells, Rocky Reach, and Rock Island Hydroelectric Projects

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Abstract: The U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS) is evaluating the decision to authorize incidental take permits pursuant to Endangered Species Act Section 10 (a)(1)(B) for 50-year anadromous fish agreements and habitat conservation plans (HCPs) with two Washington State public utility districts (PUDs [Chelan County PUD and Douglas County PUD]). The HCPs were developed to protect five species of Columbia River steelhead and salmon (spring-run chinook salmon [*Oncorhynchus tshawytscha*], summer-/fall-run chinook salmon [*O. tshawytscha*], sockeye salmon [*O. nerka*], steelhead [*O. mykiss*], and coho salmon [*O. kisutch*]), two of which are currently listed as endangered (upper Columbia River spring-run chinook salmon and steelhead) under the Endangered Species Act. The HCP's fish protection measures also satisfy the PUD's regulatory obligations under the Federal Power Act, Fish and Wildlife Coordination Act, Pacific Northwest Electric Power Planning and Conservation Act, and Title 77 RCW. The agreements would set a "no net impact" standard for salmon and steelhead protection at three hydropower projects (Wells, Rocky Reach, and Rock Island) operated by the Chelan and Douglas County PUDs, and provide the PUDs with some degree of certainty for the long-term operation of these projects. Plan coverage of the three species not listed as endangered should help prevent the need to list these species in the future. This EIS describes three alternatives. Alternative 1 is the no-action alternative that represents existing conditions under the project licenses, subsequent license amendments, and settlement agreements. Alternative 2 is application of Section 7 of the Endangered Species Act for the two endangered species and includes issuance of a biological opinion, whereas Alternative 3 represents application of Section 10 of the Endangered Species Act including issuance of an incidental take permit. Under Alternative 3, three HCPs representing Wells, Rocky Reach and Rock Island hydroelectric projects would be approved and in effect over a 50-year permit term.

Reviewers should provide NMFS with their comments during the review period of the Draft Environmental Impact Statement (DEIS). This will enable NMFS to analyze and respond to the comments at one time and to use information acquired in the preparation of the Final EIS, thus avoiding undue delay in the decision-making process. Reviewers have an obligation to structure their participation in the National Environmental Policy Act (NEPA) process so that it is meaningful and alerts the agency to the reviewer's position and contentions. Environmental objections that could have been raised at the draft stage may be waived if not raised until after completion of the Final EIS. Comments on the Draft EIS should be specific and should address the adequacy of the statement and the merits of the alternatives discussed.

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Summary

SUMMARY

S.1 PROPOSED ACTION

The U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS) is evaluating the decision to authorize incidental take permits for 50-year anadromous fish agreements and habitat conservation plans (HCPs) with two Washington State public utility districts (PUDs). The HCPs were developed to protect five species of Columbia River steelhead and salmon, two of which are currently listed as endangered under the Endangered Species Act. The fish protection measures of the HCPs are also intended to satisfy the PUD's obligations under the Federal Power Act, Fish and Wildlife Coordination Act, Pacific Northwest Electric Power Planning and Conservation Act, and Title 77 Regulatory Code of Washington (RCW). The agreements would set a "no net impact" standard for salmon and steelhead protection at three hydropower projects operated by the Chelan and Douglas County PUDs, and provide the PUDs with some degree of certainty for the long-term operation of these projects. Plan coverage of the three species not listed as endangered should help prevent the need to list these species in the future.

The anadromous fish agreements and HCPs are the result of more than 6 years of cooperative planning. In addition to NMFS and the PUDs, participants in the HCP development process are the U.S. Fish and Wildlife Service (USFWS); Washington Department of Fish and Wildlife (WDFW); the Yakama, Colville, and Umatilla Tribes; American Rivers, Inc., and the major wholesale purchasers of the PUDs electricity. [Note: Not all of these parties concur with the issues and measures identified in the current version of the HCPs.]

The NMFS is the Federal agency responsible for protecting anadromous salmon and steelhead and is the lead agency for this National Environmental Policy Act (NEPA) draft environmental impact statement (EIS). The Federal Energy Regulatory Commission (FERC) is a cooperating agency for the purposes of developing this draft EIS and the PUDs will coordinate compliance with the State Environmental Policy Act (SEPA).

To implement the HCP agreements, NMFS would issue incidental take permits under Section 10 (a)(1)(B) of the Endangered Species Act of 1973. The PUD No. 1 of Douglas County (Douglas County) is applying for a permit covering the Wells project, and the PUD No. 1 of Chelan County (Chelan County) is applying for permits to cover the Rocky Reach and Rock Island projects. The permit applications are based upon the HCPs and their exhibits.

The incidental take permits would be for four Permit species:

1. Upper Columbia River spring-run chinook salmon (*Oncorhynchus tshawytscha*),
2. Upper Columbia River summer/fall chinook salmon (*O. tshawytscha*),
3. Okanogan River and Lake Wenatchee sockeye salmon (*O. nerka*), and
4. Upper Columbia River steelhead (*O. mykiss*).

Currently, upper Columbia River steelhead and spring-run chinook salmon are listed as endangered under the Endangered Species Act. Although summer/fall chinook and sockeye salmon have not been listed, the permits apply to them according to the June 17, 1999 Federal policy governing the use of HCPs for the conservation of candidate or potential candidate species. The "no surprises policy" associated with these agreements ensures the PUDs that no additional measures will be required by NMFS for the duration of the permits, for any of the Permit species.

Coho salmon *(O. kisutch)*, an extinct species in the Mid-Columbia River region, is also included in the HCPs as a "Plan species." Recently, attempts have been made to re-introduce coho salmon into the area. Coho salmon are not considered a Permit species because an extinct species is not subject to Endangered Species Act jurisdiction. Thus, there are four Permit species and five Plan species.

S.2 PROJECT APPLICANT AND SUPPORTING ENTITIES

The project proponents are the following:

- The Douglas County PUD, a Washington municipal corporation, is sponsoring the Wells Anadromous Fish Agreement and HCP.

- The Chelan County PUD, a Washington municipal corporation, is sponsoring the Rocky Reach and Rock Island Anadromous Fish Agreements and HCPs.

The Chelan and Douglas County PUDs will file applications requesting FERC to amend their existing licenses to include the HCPs. In addition, the PUDs will rely upon the HCPs to fulfil their obligations for salmon and steelhead under new license agreements. The HCPs will meet the Endangered Species Act requirements for the permit species through the 50-year HCP terms.

S.3 PURPOSE AND NEED

The purpose of the HCPs is to protect fish in the Mid-Columbia River while generating electricity. The HCPs are needed to:

- obtain Section 10 incidental take permits, which would allow the Chelan and Douglas County PUDs to comply with the Endangered Species Act as they maintain and operate their power projects;

- support a comprehensive strategy for protecting and recovering five Plan species of anadromous salmonids in the Mid-Columbia River, two of which are currently listed as endangered under the Endangered Species Act;

- allow the Chelan and Douglas County PUDs to plan their long range operations with a degree of certainty to be able to economically operate their projects and fulfill their long-term bonding and contractual sales obligations;

- help ensure stable power supplies and pricing for the utilities' customers; and

- provide a coordinated approach to fisheries issues for relicensing the three projects under the Federal Power Act.

The HCPs are intended to constitute a comprehensive and long-term adaptive management concept for Plan species (spring-run and summer/fall chinook, sockeye, and coho salmon, and steelhead) and their habitat as affected by the hydroelectric projects.

Pending support of the HCP agreements by a coalition of Columbia River fishery resource managers and other public and private interests, their approval could reduce the risk of protests, delays or litigation during FERC relicensing for each of the three projects. They would also treat the areas around the three projects as a single habitat area, avoiding fragmentation.

The HCPs include a "no surprises" clause that provides the PUDs with a degree of certainty regarding the required mitigation and costs associated with the 50-year HCP implementation period. At the same time, there are specific performance standards, time lines and termination clauses, and an adaptive management approach to ensure that the HCPs are adequately protecting the resources.

S.4 PROJECT LOCATION

The Wells, Rocky Reach, and Rock Island hydropower projects are part of an 11-dam system on the mainstem Columbia River within the continental United States. Their location, relative to the other projects in the region, is shown in Figure S-1. Most of the projects on the mainstem Columbia River are Federally operated, although local PUDs operate five of the projects in the Mid-Columbia River segment. In addition to the three projects operated by the Chelan and Douglas County PUDs, the Grant County PUD operates the Priest Rapids and Wanapum dams.

The Douglas County PUD operates the Wells project located at river mile 515.8 on the Columbia River, north of the City of Wenatchee. Wells began commercial operations on August 22, 1967, and is operated under a license issued by FERC, which expires in the year 2012.

Chelan County PUD operates the Rock Island and Rocky Reach hydroelectric projects. Rocky Reach is about 7 miles upstream from the City of Wenatchee, at river mile 474.5. The original operating license for Rocky Reach was issued on July 11, 1957 by the Federal Power Commission. The license expires in 2006. Rock Island, which was the first project to span the Columbia River, is located about 12 miles downstream from the City of Wenatchee at river mile 453.4. Rock Island began operating in 1933, and its operating license expires in the year 2028.

The project boundaries include the forebay (from the dam to approximately 500 feet upstream), tailrace (from the dam to approximately 1,000 feet downstream), and reservoir associated with each dam. The Rock Island reservoir extends approximately 20 miles upstream of the dam to the Rocky Reach tailrace; the Rocky Reach reservoir extends approximately 41 miles upstream of the dam to the Wells tailrace; and the Wells reservoir extends approximately 30 miles upstream of the dam to the Chief Joseph Dam tailrace. Considering all components of the three projects, the entire project area extends from the tailrace of the Rock Island Dam upstream to the tailrace of Chief Joseph Dam. Project effects however, may continue downstream through the Hanford reach to the McNary Dam (inclusively defined as the action area).

All three of the hydroelectric projects discussed in this EIS are “run-of-the-river” facilities, which means that they have limited storage capacity compared to larger reservoir projects, such as Grand Coulee and Chief Joseph.

S.5 ALTERNATIVES CONSIDERED IN DETAIL

S.5.1 ALTERNATIVE 1 (NO ACTION)

Alternative 1 represents baseline conditions, which include the FERC licenses and amendments that govern current operations. These licenses cover all aspects of dam operation, as well as resource protection. Under Alternative 1, analyses in this EIS review how the licenses and the applicable amendments affect the environmental resources within the project area, including mitigation sites and hatcheries that may be outside of the immediate project boundary.

Provided below are the protection measures pertinent to anadromous fish for direct comparison

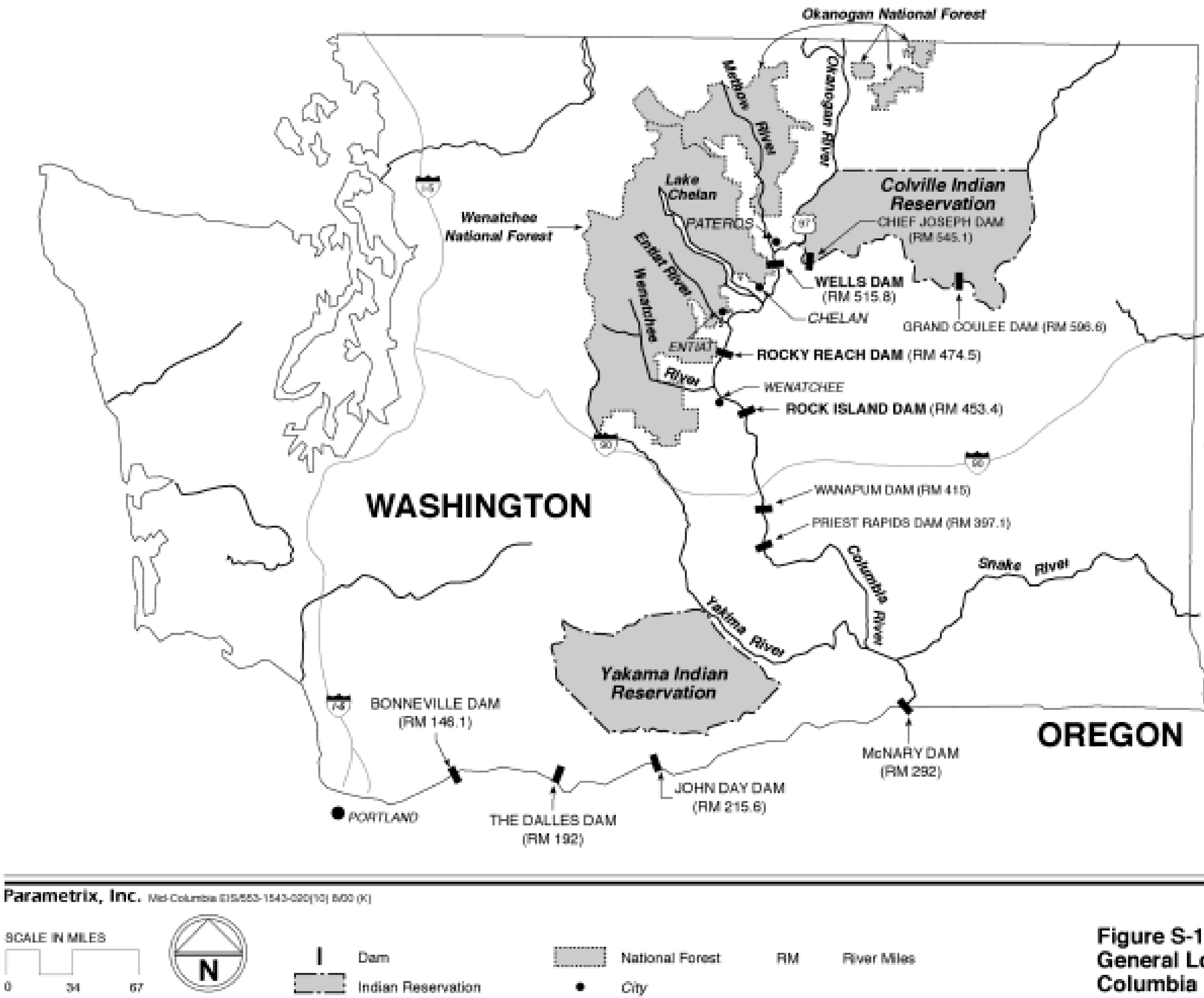


Figure S-1
General Location of Columbia River Dams

to Alternatives 2 and 3, which pertain primarily to either two endangered fish species (Alternative 2) or five Plan species of anadromous fish (Alternative 3).

S.5.1.1 Wells Hydroelectric Project

The original FERC license stipulated that two adult fishladders would be constructed at the Wells Project (adjacent to each embankment), as well as a “low bucket” spillway design that was approved by the State of Washington Department of Fisheries and Game (FERC 1962a). A subsequent amendment to the license stipulated a general requirement to provide mitigation for project construction, alteration, and operations, and to comply with reasonable requests to modify project structures and operations in the interest of fish and wildlife (FERC 1962b). Project structure revisions were approved in 1970 to comply with fishery agency requirements regarding fishladder design and operation (FERC 1970). The FERC (1982) amended the license to raise the forebay elevation by two feet.

In 1990, the Douglas County PUD, the Wells Project power purchasers, resource agencies, and Tribes entered into a long-term fisheries settlement agreement regarding the Wells Project (FERC 1991). The 1990 Wells Settlement Agreement established the Douglas County PUD's obligations for the installation and operation of juvenile downstream migrant bypass facilities, hatchery compensation for fish losses, and adult fishway operations, through at least March 1, 2004. These measures, in conjunction with existing hatchery compensation programs, were considered to fulfill Douglas County PUD's obligation to protect, mitigate and compensate for the effects of the Wells Project on anadromous fish. The agreement also stipulates evaluation programs for fishery measures and establishes procedures for coordination among the PUD, it’s power purchasers, and the Joint Fishery Parties through the Wells Coordinating Committee. Coordinating Committee decisions are made on a consensus basis.

The 1990 Wells Settlement Agreement established the requirements for the PUD to fund, operate, maintain and evaluate three anadromous fish related programs. These programs consist of: (1) juvenile fish passage measures, (2) adult fish passage measures, and (3) hatchery-based compensation measures.

Juvenile Fish Passage

The juvenile fish passage program called for the installation and evaluation of a juvenile bypass system to route juvenile salmonids around turbine units. The established program uses controlled spill through modified spill bays to provide a non-turbine passage route through the project. The agreement includes specific operation, performance, and evaluation standards, as well as procedural guidelines for modifying the operational components of the system if necessary to meet the performance standards. The performance standards are set to provide fish passage efficiency (the percentage of fish bypassing the project through non-turbine routes over the total population of fish passing the project) of at least 80 percent during the juvenile spring-run migration period and at least 70 percent during the juvenile summer migration period.

Adult Fish Passage

The 1990 agreement called for evaluations of adult delay and mortality at the project beginning in 1991. If the evaluations identified delays and/or mortality, the agreement specified that operational modifications would be used to alleviate the problems. If those modifications could not correct the problems, the adult fishways would be modified.

Hatchery-Based Compensation

Under the Wells Settlement Agreement, the PUD agreed to fund a hatchery program to mitigate for fish passage losses at the Wells Dam. The agreement identifies specific production levels for the anadromous fish species affected by the project that are in addition to the existing mitigation program at the Wells Dam. The agreement also provides the ability to adjust these additional compensation levels based on actual juvenile and adult losses at the dam. However, production levels based on impacts of project inundation would not be altered. The agreement also establishes specific operational standards for the fish production facilities.

Measures Planned

The existing fish mitigation and compensation measures for the Wells Dam were developed through the Wells Settlement Agreement and subsequent negotiations within the Wells Coordinating Committee. A summary of measures expected to continue under Alternative 1 are:

1. Adult Passage:

    a. Continue operation and maintenance of the existing adult fishways.

    b. Investigate entrance and ladder modifications that may be necessary to improve ladder operation and minimize fish passage delay.

    c. Conduct modeling or other appropriate evaluations to determine the best actions for correcting any significant delay.

    d. Develop solutions and implement corrective actions where adult passage problems are identified. Specifically, improve the efficiency of the existing fishways by maximizing the number of adult migrants that enter the facilities.

    e. Continue operation of the juvenile surface bypass system from April through August to provide a fallback and downstream passage route for adult spring-run chinook salmon and steelhead through the dam.

2. Juvenile Passage

    a. Turbine Operations - Operate turbines at peak efficiency ratings, to the extent possible.

    b. Surface Bypass Operation - Operate at least one spillway bypass, 24 hours a day, throughout the juvenile downstream migration periods. The operation of the five bypass system bays (# 2,4,6,8 and 10) will be paired with associated turbine units. (Table S-1).

    c. Predators - continue to refine and implement a northern pikeminnow removal program.

    d. Gas Abatement - Control total dissolved gas levels under total river flows up to the 7-day 10-year peak flow event to 120 percent of saturation.

3. Hatchery Program

    Continue to provide funding and hatchery capabilities to rear and release up to 49,200 pounds of spring-run chinook, 32,000 pounds of yearling summer chinook, 24,200 pounds of sub-yearling summer chinook, 8,000 pounds of sockeye, and 80,000 pounds of yearling steelhead, according to provisions in the settlement agreement. Under the settlement agreement, hatchery production for unavoidable losses could be reduced if survival studies indicate that fish passage mortality is less than the assumed 14 percent, which was the basis for the current mitigation level.

4. Monitoring and Evaluation

    a. Juvenile Run Timing - Utilize hydroacoustic techniques to determine the timing of bypass system operations.

    b. Survival - Develop and utilize the best techniques to estimate the survival of juvenile salmon and steelhead passing the project. Techniques may include the use of radio-telemetry or tag release and recapture methodologies.

TABLE S-1. SUMMARY OF EXISTING BYPASS SYSTEMS AND SPILL OPERATIONS AT WELLS, ROCKY REACH, AND ROCK ISLAND DAMS

PROJECT	BYPASS SYSTEM	PERIOD OF OPERATION
Bypass Systems/Operations		
Wells	Surface bypass (baffled spill gates with discharge through controlled spill of up to 8% of total river discharge)	24 hours/day; between at least April 10 and August 15, depending on the hydroacoustic index of juvenile fish migration timing
Rocky Reach	Turbine screens in two units; prototype surface bypass (discharge through conduit to tailrace)	Continue to evaluate and improve the efficiency of the bypass system, and provide spill as an interim measure (see below)
Rock Island	Passive gatewell orifice bypass (discharge through conduit to tailrace)	24 hours/day (spill is the primary bypass system used at Rock Island as described below)
Spill Operations		
Wells	See bypass operations (above)	See bypass operations (above)
Rocky Reach	15% of previous day's average flow in spring-run	30 days with an additional 6 days if necessary to encompass 90% of the Okanogan River sockeye run
	10% of previous day's average flow in summer	Total of 34 days between June 15 and August 15
Rock Island	Spring and summer spill purchased by joint request of the Fisheries Agencies and Tribes from a Fisheries Conservation Account of $2.05 million (1986 dollars adjusted for inflation) at the market price of energy	The Fisheries Agencies and Tribes decide when and how much spill to purchase based on funds available in the Fisheries Conservation Account

c. Total Dissolved Gas Monitoring – Monitor total dissolved gas levels and temperature at fixed location monitors in the forebay and downstream of the dam. Provide biological monitoring to determine the incidence of gas bubble disease symptoms in adult salmonids.

d. Fish Counting - Provide adult fish counts on a 24-hour basis.

S.5.1.2 Rocky Reach Hydroelectric Project

The existing fishery protection measures undertaken by the Chelan County PUD for the Rocky Reach Dam are the result of mitigation and compensation requirements in the original project license and subsequent amendments (FERC 1953, 1957a, 1957b, and 1968), as well as an interim stipulation resulting from the Mid-Columbia Proceedings (Docket No. E-9569 [FERC 1987a]). The interim stipulation was an agreement between the Chelan County PUD and the Joint Fishery Parties with respect to juvenile and adult fish passage measures and hatchery compensation levels to mitigate for impacts resulting from project operations. The interim stipulation identified compensation and operational requirements that would be in effect from July 1, 1987 through August 31, 1988. Subsequently, the stipulation was extended and revised several times (FERC 1989b, 1991b, and 1993c). The latest revision (Fourth Revised Interim Stipulation) was negotiated to include the period September 1, 1995 through December 31, 1997 (FERC 1996b). Although there is no current agreement for Rocky Reach, Chelan County PUD has continued to operate the project in coordination with the Mid-Columbia Coordination Committee, as it has under the previous stipulations. Coordinating Committee decisions are made on a consensus basis.

The main goal of the Fourth Revised Interim Stipulation was to develop a safe (less than 2 percent mortality) juvenile bypass system capable of bypassing 80 percent of the juvenile salmon and steelhead over 90 percent of the migration period. Passage efficiency would then be used in developing a survival based performance standard for the Rocky Reach Project. This agreement led to the development of prototype surface bypass system that was installed at Rocky Reach Dam in the fall of 1994. Since that time, the bypass system has been modified based on the results of hydraulic modeling and fish passage evaluations. During development of the surface bypass system, the Fourth Revised Interim Stipulation provided a protection plan for juvenile migrants through the use of spill.

Despite the expiration of the interim stipulation, Chelan County PUD has continued implementation of the associated programs through coordination with the Mid-Columbia Coordinating Committee. The fish protection measures consistent with the 4th Revised Interim Stipulation include:

1. Continue operation and maintenance of the adult fishways.

2. Spill at a level equal to 15 percent of the daily average flow for a 30-day period, with up to 6 additional days to compensate for the Okanogan River sockeye run in the spring-run. In the summer, spill at a level equal to 10 percent of the daily average flow for a total of 34 days between June 15 and August15 (Table S-1).

3. Construct a permanent juvenile bypass facility capable of bypassing 80 percent of the juvenile migrating salmon and steelhead over 90 percent of the migration period.

4. Continue to refine and implement a northern pikeminnow removal program, as well as continue to fund a hazing program to minimize the loss of juvenile fish to avian predators.

5. Continue to provide funding and hatchery facilities adequate to rear and release up to 54,400 pounds of fall chinook and 30,000 pounds of steelhead annually.

S.5.1.3 Rock Island Hydroelectric Project

The original FERC license for the Rock Island Dam was issued in 1930 and construction was completed in 1933. In 1987, the Chelan County PUD, Puget Sound Energy (formerly Puget Sound Power & Light), resource agencies, and Tribes entered into a long-term fisheries settlement agreement for the Rock Island Hydroelectric Project (FERC 1987b). The provisions in the settlement agreement were included in the documentation for relicensing the project in 1989 (FERC 1989c). The Rock Island Settlement Agreement was amended in 1993 to replace the requirement to conduct an adult fish mortality study with the requirement to conduct an adult fish passage study (FERC 1993b).

The Rock Island Settlement Agreement established the requirements for the PUD to fund, operate, maintain and evaluate three anadromous fish related programs. These programs consist of: (1) juvenile fish passage measures, (2) adult fish passage measures, and (3) hatchery-based compensation measures. Coordinating Committee decisions are made on a consensus basis.

Juvenile Fish Passage

The Rock Island Settlement Agreement called for a bypass development program to study, design, develop, test, and install a mechanical juvenile fish bypass system at the project. The performance standards targeted for the bypass system included achieving at least 80 percent fish passage efficiency during the spring-run migration period and at least 70 percent fish passage efficiency during the summer migration period. Unfortunately, subsequent efforts to develop an adequate mechanical solution to the juvenile bypass issue were unsuccessful. Therefore, the PUD is currently evaluating modifications at the spillway to increase the rate of non-turbine passage at the project and use a conservation account to provide spill.

As an alternative to juvenile bypass system development, the agreement established a Fisheries Conservation Account. This account (with an annual funding level of $2.05 million in 1986 dollars) could be used by the fishery agencies and Tribes to purchase spill as a means to increase the non-turbine passage of juvenile fish at the project.

Adult Fish Passage

The agreement called for modifications to the adult fishladder at Rock Island Dam to meet fishery agency operating standards, as well as a comprehensive hydraulic evaluation of the right bank ladder to ensure that the design flows were met.

Hatchery-Based Compensation

Under the Rock Island Settlement Agreement, the PUD agreed to construct, maintain, and fund a hatchery program to mitigate for fish passage losses at the Rock Island Dam. The agreement identifies the specific construction standards, production levels and evaluation procedures to be implemented. The agreement also provides the ability to adjust these additional compensation levels based on actual juvenile and adult losses at the project, although production levels intended to compensate for project inundation would not be altered. The agreement also establishes specific operational standards for the fish production facilities.

Fish protection measures developed in the Rock Island Settlement Agreement and included in Alternative 1 are:

1. Modify the existing adult fishladders so their operation meets current fishery agency operating criteria.

2. Utilize the conservation account to provide spill for spring and summer outmigrants up to $2.05 million (in 1986 dollars).

3. Continue to provide funding and hatchery capability to rear and release 250,000 pounds of salmon and 30,000 pounds of steelhead in a manner that is consistent with the maintenance of genetically distinct stocks.

4. Evaluate fish guidance efficiency using hydroacoustic and direct capture methods including assessments of injury and stress, and evaluate the hatchery programs, including sampling to determine hatchery versus natural components of steelhead returns, and an evaluation of hatchery production and its inter-relationship with natural production.

S.5.2 ALTERNATIVE 2 (SECTION 7 CONSULTATION)

In order for the utilities to be exempt from the take prohibitions imposed under Section 9 of the Endangered Species Act, they must consult with NMFS either directly via Section 10 (a)(1)(B) or indirectly through FERC under Section 7 (a)(2). Under Alternative 2, Section 7 (a)(2) consultations would produce a biological opinion following consultations between NMFS and FERC. As a result, the Wells, Rocky Reach and Rock Island hydroelectric projects would be operated according to existing FERC licenses and settlement agreements for unlisted species and according to additional measures potentially required as a result of this consultation process for listed species.

The Section 7 (a)(2) formal consultation process results in NMFS issuing a biological opinion on the effects of the proposed actions. In this case, the proposed actions are continuing operation of the Wells, Rocky Reach, and Rock Island hydroelectric projects. With the assistance of each utility, FERC would provide NMFS with the following information:

- a description of the action being considered;
- a description of the specific area that may be affected by the action;
- a description of any listed species or critical habitat that may be affected by the action;

- a description of the manner in which the action may affect any listed species or critical habitat; and

- an analysis of the cumulative effects, relevant reports and analyses prepared on the proposal, and, any other relevant studies or information on the action, the affected species, or critical habitat.

The NMFS would then evaluate this information and any other information available to determine whether the proposed action was likely to jeopardize the continued existence of listed species or was likely to result in the destruction or adverse modification of critical habitat. Depending on this conclusion, NMFS would potentially require additional protection measures to ensure that listed species would continue to persist into the future with adequate potential for recovery (up to full mitigation for the project effects). Under this process, FERC would then have the responsibility of ensuring that measures identified in the biological opinion were implemented at the PUD projects. The PUDs may either implement measures required by the biological opinion and FERC, or formally object to the mandatory requirements through litigation.

The Section 7 (a)(2) biological opinion is considered a living document that would be updated at any time given new information. Specific measures required in the initial biological opinion may be modified or new measures may be required as a result of this process. In addition, if other species were listed under the Endangered Species Act, additional consultation processes would occur. Although NMFS has not determined what, if any, additional measures would be required over the next 50 years to protect listed species, it is likely that they would require all measures necessary to ensure that the proposed actions were not likely to jeopardize the continued existence of endangered species or result in the destruction or adverse modification of critical habitat.

Measures may include corrective actions at the projects to improve survival through the action area and offsite mitigation measures if project specific measures were determined to be insufficient to recover listed species (offsite measures would likely be proposed before consideration of non power options).

Based on completed consultations at other mainstem Columbia and Snake River hydroelectric projects, protection measures would likely include a combination of the following:

- Measures that allow for increased upstream passage of adult fish through fishways and reservoirs and decreased fish injury and pre-spawning mortality (examples include hydraulic and structural fishway improvements – specifically, ladder modifications and improved attraction flow to help move fish more quickly into the ladder systems and over the dams).

- Measures that provide for increased downstream passage of juvenile salmonids while minimizing fish injury (examples include increased spill programs [in association with operational and structural modifications to reduce total dissolved gas levels], expanded predator control programs, drawdown, and the development of improved fish bypass systems).

- If necessary to meet recovery standards, offsite compensation measures, such as tributary habitat improvements or artificial propagation may also be proposed (prior to requiring non power options).

These measures would be directed only at listed species and would possibly only occur during specific periods (seasonal). As a result, the benefits of these measures may not apply to unlisted species.

Initial survival standards for protection of the species have been developed as a result of preliminary survival information and life-history analyses. Evaluations conducted as part of the Quantitative Analytical Report (QAR) (NMFS

2000b) indicate a substantial risk of extinction for Mid-Columbia River spring-run chinook salmon and steelhead if recent ocean and freshwater survival rates continue. The Wenatchee River spring-run chinook and Methow River steelhead populations have the highest extinction risks based on these modeling assessments.

Expanding the baseline survival rates to reflect those observed from the 1960s through 1990 would lower the projected extinction risks to a degree, although these survival assumptions may be overly optimistic. Under all but the most optimistic scenarios, improvements in the average population growth rates are necessary to lower the extinction risks to acceptable levels (i.e., to levels below the extinction risks criteria established by the QAR workgroup).

Even assuming hatchery supplementation could increase population sizes to the interim recovery levels, these levels cannot be sustained naturally under recent total life-history survival rates. According to the QAR analyses, even the removal of the Mid-Columbia River dams would not be sufficient to recover these species if recent total life-history survival rates continue. Therefore, in addition to improved survival through the middle and lower Columbia River projects, and during the early life stages of the fish, improved environmental/climate conditions are necessary for the listed species to survive and recover.

Each measure implemented under Alternative 2 would continue until such time that NMFS determine that:

- other protective measures would increase survival,
- the proposed measures are determined to be ineffective or unsuccessful in increasing fish survival, or
- a species is delisted and it is determined that a previously approved protection measure is no longer warranted.

The decision to apply specific measures at each dam would depend on the benefit of the measures to Endangered Species Act-listed fish species, and not necessarily to all species passing through the projects. However, it is envisioned that each dam would have a combination of juvenile bypass options including a screened bypass and/or a surface bypass system, a spill program designed to maximize non-turbine passage, and improvements to the adult facilities intended to maximize project and pre-spawning survival.

If listed fish populations continue to decline, NMFS would likely find that additional protection measures are needed. Most of these additional measures may be in-water facility improvements although additional offsite measures would likely be recommended prior to requiring any decommissioning or drawdown options.

If required, natural river drawdown would have significant and substantial environmental effects to many of the existing natural, physical, and social resources. However, this type of operation would help to mimic the natural river conditions that existed prior to the construction of the hydroelectric facilities, and thereby minimize the impacts caused by the hydro system.

Although not recommended by a Federal, State, or local agency at this time, the review of natural river drawdown was requested by organizations during public scoping for this EIS. Consequently, natural river drawdown at the three dams (Wells, Rocky Reach, and Rock Island) has been evaluated for Alternative 2 at a brief summarizing level to help understand and compare the overall differences between the alternatives. Although natural river drawdown is not an option under the existing FERC licenses, it could be evaluated during relicensing procedures. The current FERC licenses expire in 2006, 2012, and 2028 for the Rocky Reach, Wells, and Rock Island dams, respectively.

Drawdown to minimum operating pool (seasonal reservoir drawdown), which is an option under the current licenses, has not been shown to increase juvenile survival in the Mid-Columbia River. Therefore, it was not evaluated in this EIS.

S.5.2.1 Wells Hydroelectric Project

In 1990, the Douglas County PUD, the Wells project power purchasers, resource agencies, and Tribes entered into a long-term fisheries settlement agreement for the Wells Project. This agreement established the Douglas County PUD's obligation for the installation and operation of juvenile downstream migrant bypass facilities; hatchery compensation for fish losses, and adult fishway operation. These measures, in conjunction with existing hatchery compensation programs, were considered to fulfill the Douglas County PUD's obligation to protect, mitigate and compensate for the effects of the Wells project on the anadromous fish resource.

Initial compensation was established at 14 percent based on the estimated survival of juvenile salmonids passing through the original turbine units. Measures undertaken by the Douglas County PUD that would likely continue to be incorporated in a long-term fish recovery plan include those proposed in the existing biological assessments for the project (Douglas County PUD 1998, 1999a) and resulting interim biological opinion (NMFS 2000b). Additional measures may also be required by NMFS, including any actions necessary to increase the survival of listed species.

Measures currently anticipated to be part of the protection program required by NMFS include:

1. Adult Passage – In addition to the measures described under Alternative 1 for Wells Dam:
    a. Conduct evaluations on spawning success and fecundity as it relates to passage through a multiple dam system.
    b. Operate the surface bypass system during the upstream adult steelhead and spring-run chinook migration periods and during the downstream kelt passage period to maximize the survival of fallbacks and downstream migrating adults.
2. Juvenile Passage – Operating within 1 percent of peak turbine efficiency at all times during the juvenile and adult listed species passage periods would be required, with appropriate reporting and monitoring requirements to ensure compliance.
3. Hatchery Program – The same amount of chinook, sockeye, and steelhead would be produced as described under Alternative 1. In addition, Douglas County PUD would fund the changes in hatchery procedures and evaluations needed to make the hatchery compensation program consistent with recovery of spring-run chinook salmon and steelhead populations.
4. Monitoring and Evaluation – Measures are the same as described under Alternative 1 for juvenile run timing, survival, total dissolved gas monitoring, and fish counting. The following additional measures are expected to be implemented:
    a. Cumulative Effects - In conjunction with NMFS, develop methodologies and conduct evaluations to assess the effects of passage through multiple dam systems on the fecundity, spawning success, and survival of adult spring-run chinook salmon and steelhead.
    b. Evaluate adult fishladder passage standards, as they relate to spring-run chinook salmon and steelhead, and modify facilities as needed.

As stated, NMFS would require any additional measures necessary to recover listed species based on information obtained from monitoring and evaluation of project survival and on the species recovery status.

S.5.2.2 Rocky Reach Hydroelectric Project

Long-term protection measures for the Rocky Reach Dam would likely be similar to those described in biological assessments submitted to NMFS in 1998 and 1999 (Chelan County PUD 1998a, 1999a) as well as any additional measures necessary to maximize survival and recovery of listed species, based on additional information available to NMFS and as a result of continued monitoring and evaluation.

Measures currently anticipated to be part of the protection program required by NMFS include:

1. Adult Passage – In addition to continuing operation of the fishladders:

    a. Enhance the fishway entrance attraction conditions through planned operation of spill gates and turbines.

    b. Investigate ladder modifications to improve operations within specified standards, and minimize fish passage delay.

    c. Provide safe downstream passage facilities for adult fallbacks and kelts (e.g., bypass system operations, spill, etc.).

    d. Conduct modeling or other appropriate evaluations to determine the best actions for correcting passage problems, and implement measures as necessary.

    e. Conduct evaluations on spawning success and fecundity as it relates to passage through a multiple dam system.

2. Juvenile Passage – Measures in addition to those described in Alternative 1 would include:

    a. Construct a permanent juvenile bypass system to NMFS criteria that maximizes the non-turbine passage of listed species.

    b. Operate turbine units within 1 percent of peak turbine efficiency at all times during the juvenile and adult listed species passage periods, with appropriate reporting and monitoring to ensure compliance.

    c. Increase spill as necessary to prevent the extinction of listed species.

    d. Implement measures to ensure that total dissolved gas levels are maintained below 120 percent of saturation under total river flows up to the 7-day 10-year peak flow event.

    e. Implement effective predator control measures.

3. Hatchery Program – The same amount of chinook and steelhead would be produced as described under Alternative 1. In addition, fund the changes in hatchery procedures and evaluations needed to make the hatchery compensation program consistent with recovery of spring-run chinook salmon and steelhead populations.

4. Monitoring and Evaluation – In addition to those measures described under Alternative 1:

    a. Cumulative Effects – In conjunction with NMFS, develop methodologies and conduct evaluations to assess the effects of passage through multiple dam systems on the fecundity, spawning success, and survival of adult salmonids.

    b. Survival - Utilize the best techniques to estimate the survival of spring-run chinook salmon and steelhead through the project. Techniques would likely include the use of PIT-tags for juveniles and radio-telemetry methodologies for adults.

    c. Total Dissolved Gas Monitoring - Conduct physical monitoring of total dissolved gas levels and temperature within the project area. Conduct biological monitoring to determine the incidence of gas bubble disease symptoms in juvenile steelhead and spring-run chinook.

d. Fish Counting - Provide adult fish counts on a 24-hour basis.

e. Evaluate adult fish passage efficiencies through radio telemetry studies.

As stated, NMFS would require any additional measures necessary to prevent the extinction of listed species based on information obtained from monitoring and evaluation requirements imposed under Alternative 2, and on the species recovery status.

S.5.2.3 Rock Island Hydroelectric Project

Long-term protection measures for the Rock Island Dam would likely be similar to those described in biological assessments submitted to NMFS in 1998 and 1999 (Chelan County PUD 1998b, 1999c), as well as any additional measures necessary to maximize the survival and recovery of listed species, based on additional information available to NMFS and as a result of continued monitoring and evaluation.

Measures currently anticipated to be a part of the protection program required by NMFS include:

1. Adult Passage –In addition to continuing operation of the fishladders:

   a. Provide safe downstream passage facilities for adult fallbacks and kelts (e.g., bypass system operations, spill, etc.).

   b. Evaluate passage facilities through hydraulic evaluations and adult passage studies and correct problems when identified.

   c. Investigate ladder modifications to improve operations within specified standards, and minimize fish passage delay.

   d. Conduct evaluations on spawning success and fecundity as it relates to passage through a multiple dam system.

2. Juvenile Passage – Measures in addition to those described under Alternative 1 would likely include:

   a. Construct a permanent juvenile bypass system to NMFS criteria that maximizes the non-turbine passage of listed species.

   b. Operate turbine units within 1 percent of peak turbine efficiency at all times during the juvenile and adult listed species passage periods, with appropriate reporting and monitoring to ensure compliance.

   c. Increase spill as necessary to prevent the extinction of listed species.

   d. Implement measures to ensure that total dissolved gas levels are maintained below 120 percent of saturation under total river flows up to the 7-day 10-year peak flow event.

   e. Implement effective predator control measures.

3. Hatchery Program – The same amount of salmon and steelhead would be produced as described under Alternative 1. In addition, fund the changes in hatchery procedures and evaluations needed to make the hatchery compensation program consistent with recovery of spring-run chinook salmon and steelhead populations.

4. Monitoring and Evaluation – In addition to those measures described under Alternative 1:

   a. Cumulative Effects - In conjunction with NMFS, develop methodologies and conduct evaluations to assess the effects of passage through multiple dam systems on the fecundity, spawning success and survival of adult salmonids.

b. Survival - Utilize the best techniques to estimate the survival of spring-run chinook salmon and steelhead through the project. Techniques would likely include the use of PIT-tags for juveniles and radio-telemetry methodologies for adults.

c. Total Dissolved Gas Monitoring - Provide physical monitoring of total dissolved gas levels and temperature within the project area. Provide biological monitoring to determine the incidence of gas bubble disease symptoms in juvenile steelhead and spring-run chinook.

d. Fish Counting - Provide adult fish counts on a 24-hour basis.

e. Evaluate adult fish passage efficiencies through radio-telemetry studies.

As stated, NMFS would require any additional measures necessary to recover listed species based on information obtained from monitoring and evaluation requirements imposed under Alternative 2, and on the species recovery status.

S.5.3 Alternative 3 (Applicants' Proposed Action – Project HCPs)

The applicants' proposed action consists of implementing the three HCPs for the operation of the Wells, Rocky Reach, and Rock Island hydroelectric projects. The HCPs were developed to conserve and protect listed *and* non-listed anadromous fish species over the long term, and to support ongoing compliance with the Endangered Species Act, while allowing continued operation of the three projects. The HCPs would be comprehensive long-term settlement agreements under the Endangered Species Act, the Federal Power Act, the Fish and Wildlife Conservation Act, the Northwest Power Planning and Coordination Act, and Title 77 RCW.

This EIS reviews only NMFS' decision to issue the incidental take permits required by the HCPs. NMFS is not required to prepare an EIS for its decision to sign the settlement agreement portions of the HCPs (the EIS required for implementing measures in the HCPs would be undertaken by FERC with a separate Section 7 consultation with NMFS regarding the effects of the settlement agreements on listed species).

The requirements of Section 10 of the Endangered Species Act provide the guidelines for HCP preparation. The information within each of the HCPs includes the following:

- the environmental setting in the project vicinity,
- structural and operational features of the project,
- existing operations related to anadromous salmonids,
- existing mitigation and monitoring measures, and their effectiveness,
- unresolved issues related to anadromous salmonids (note: an adaptive management plan to address changing circumstances and unknown future events addresses this issue in the proposed HCPs),
- proposed mitigation and enhancement measures to address unresolved and unknown future issues (note: an adaptive management plan to address changing circumstances and unknown future events addresses this issue in the proposed HCPs),
- proposed monitoring,
- costs and funding, and
- alternatives to the proposed measures.

S.5.3.1 HCP Species

In addition to the Endangered Species Act-listed species, the HCPs provide additional protection to the other anadromous fish species that occur in the Mid-Columbia River (Plan species).

The Plan species addressed in the HCPs are spring-run chinook salmon, summer/fall chinook salmon, sockeye salmon, coho salmon, and steelhead inhabiting the Mid-Columbia River basin. In addition, the HCPs also identify Permit species (species covered under the incidental take permit application). The Permit species include all the Plan species, except coho salmon. The native coho salmon populations are considered extirpated from the Mid-Columbia River region, and are therefore not subject to Endangered Species Act protection or an incidental take permit.

S.5.3.2 HCP Baseline Conditions

The HCPs do not address impacts resulting from original project construction or mitigation for past damages (Regulations Preambles 1986-1990, FERC Stats. and Regs, paragraph 30,869 at 31,613 (1989), 55 Fed. Reg. 4:8-9 (Jan. 2, 1990). Mitigation measures for these impacts have already been implemented as part of the existing licenses. Prior activities are not considered an action subject to additional mitigation beyond license requirements unless they are considered to cause a continuing "take " of a listed species as defined under the Endangered Species Act.

Existing hatchery production levels are initially assumed to provide adequate compensation for original inundation by the projects. Therefore, the baseline is considered to be the existing conditions.

These baseline conditions also form the basis for determining what effect continuation of the existing conditions would have on listed species. The baseline conditions that existed as of January, 1997, would be used to determine if progress were being made to increase the survival of the Plan species through the implementation of the HCPs.

S.5.3.3 HCP Term

The terms of the three HCPs and any incidental take permits are to be 50 years from the date the HCPs are executed. In the event any PUD project is not relicensed to that PUD, the component HCP for that project would terminate.

The HCPs also have termination provisions if the performance standards are not achieved. An HCP could be less than 50 years under the following circumstances:

- FERC issues a non-power license for the project,
- FERC orders removal or drawdown of the project, or
- 15 years after March 1, 1999 (20 years for Douglas County PUD) if no net impact has not been achieved or maintained, or if no net impact has been achieved and maintained but Plan Species are not rebuilding and the Project is a significant factor in the failure to rebuild,
- if a party fails to comply with the terms of the HCP,
- if the obligations imposed by the HCP are impossible to achieve,
- if NMFS revokes the incidental take permit,
- if a regulatory entity takes action that materially alters or is contrary to one or more provisions of the HCP.

Any party to the HCP (except the PUDs) may elect to withdraw from the agreement at any time, based on the non-compliance provisions of the HCP agreements. However, NMFS and USFWS will not exercise their right to withdraw from the HCP if the PUDs have complied with all aspects of the agreement but have not met the survival standards. If mutual agreement is reached between the PUDs and the two Federal agencies, the Services (NMFS and USFWS) can seek natural river drawdown, dam removal, and/or non-power operations without withdrawing from the agreement or suspending or revoking the Incidental Take Permit.

During the 50-year HCP term, all three projects would undergo a relicensing process with FERC. It is the intention of the PUDs that mitigation measures agreed to as part of the HCP be consistent with, and where possible form the basis of subsequent FERC license articles developed to address impacts on anadromous salmonids. Therefore, unless the parties to the HCPs withdraw from the HCP agreements (following the prescribed withdrawal procedures), they will be supportive of a new license, and the HCPs would constitute the terms, conditions, and recommendations for Plan species under Section 10 (a), Section 10 (j), and Section 18 Fishway Prescriptions in the new license.

The HCP agreements stipulate a dispute resolution procedure that would apply to all disputes over the implementation and compliance of the agreements. While it is the intention of the parties to utilize dispute resolution whenever possible, NMFS specifically reserved the right to use whatever enforcement powers and remedies are available under the Endangered Species Act by law or regulation, without first resorting to this resolution process. In the event that NMFS elects to pursue an enforcement action for a violation under the Endangered Species Act, the PUDs shall be given notice and an opportunity for a hearing with respect to such violation. It should be noted that measures consistent with the HCP agreements and protocols, by definition could not violate the Endangered Species Act.

S.5.3.4 HCP Mitigation Objectives

All measures proposed in the HCPs are intended to minimize and mitigate impacts to the Plan species, to the "maximum extent practicable" as required by the Endangered Species Act. Measures are developed by considering what is necessary from a biological standpoint to mitigate impacts of operating the hydroelectric facilities on the Plan species, and what the PUDs determine is economically feasible in terms of the continued operation of PUD facilities.

The HCPs would mitigate impacts from dam operations in areas directly affected by those operations (project areas). The project areas extend from approximately 1,000 feet downstream of each dam (tailrace) to about 1,000 feet downstream of next dam upstream (reservoir). The PUDs would also provide funding and other assistance for off-site measures intended to increase the natural productivity of Plan species, to offset losses not directly mitigated within the project areas. These off-site measures might also benefit other aquatic species, which might occupy the same habitat.

S.5.3.5 HCP Performance Standards

The HCPs have specific performance standards that relate to the survival of each Plan. The overall performance standard is to achieve no net impact to the Plan species through each dam, and is referred to as "100 percent no net impact." This term takes into account the fact that 100 percent survival cannot be achieved at the projects alone, but also must include off-site measures to increase salmonid productivity (e.g., hatchery supplementation programs and tributary habitat improvements).

The 100 percent no net impact standard consists of two components:

1) 91 percent project survival rate achieved within the geographic area of the projects by fish passage improvement measures, including an independent standard of 95 percent juvenile dam passage survival.

2) 9 percent compensation for unavoidable project mortality provided through hatchery and tributary programs, with 7 percent compensation provided through hatchery programs and 2 percent compensation provided through tributary habitat improvement programs.

Tributary habitat improvement programs would involve the protection and restoration of salmonid habitat within the Columbia River watershed (from the Chief Joseph tailrace to the Rock Island tailrace), and the Okanogan, Methow, Entiat, and Wenatchee river basins.

The PUDs would use “best efforts” to evaluate, improve, maintain, and operate adult and juvenile fish passage systems to meet the performance standards. Best efforts are referred to as “tools” which are any action, structure, facility or program (on-site only) that are intended to improve the survival of Plan species migrating through the project areas.

Monitoring of both on-site and hatchery mitigation measures would be conducted, and mitigation measures would be modified, as necessary, to achieve or maintain 100 percent no net impact, provided that no more than 7 percent of unavoidable project mortality would be supplied through hatchery compensation without concurrence of the Joint Fisheries Parties. Two percent of the unavoidable project mortality will be compensated for by tributary habitat improvements. However, this component will not be monitored for survival contribution or modified during the 50-year term of the HCPs due to the difficulty and uncertainties associated with monitoring and quantifying the effects of tributary habitat improvements.

The no net impact standard represent input from NMFS, USFWS, and WDFW biologists, and was developed in coordination with tribal and PUD biologists. In addition, it is consistent with the performance standards included in Section VIII.A.15 of the 1995 Federal Columbia River Power System biological opinion for the lower Snake and Columbia River projects (NMFS 1995). In-river survival evaluations would determine if the survival standards were being met.

The no net impact and survival standards are designed to have several layers of requirements to provide the most flexibility to achieve the goal of recovering and stabilizing the anadromous fish runs in the Mid-Columbia River. For example, while the 95 percent juvenile dam passage survival standard is applicable to 95 percent of the run period of each species, the 91 percent project survival standard is a requirement of the entire run. In addition, the 91 percent survival standard also includes reservoir survival and the dam passage survival of returning adults.

Although there is limited survival information available for all the Plan species at each of the three dams, recent improvements in fish tagging technology (e.g., passive integrated transponder [PIT]-tags, miniature radio, sonic and balloon tags) will provide much more detailed and accurate future assessments. These tag improvements and other assessment techniques should provide quantifiable survival estimates through the entire project areas, as well as individual passage routes.

The overall survival rate estimates would determine if the survival standards are being met. However, the off-site compensation activities (e.g., hatchery production and tributary improvement activities) are based on specific levels that are assumed to be adequate. These compensation levels would not be increased.

The HCPs set an initial 5-year period for the PUDs to meet the 95 percent juvenile dam passage survival standard followed by up to 3 years of evaluation. If the survival standards are not met, the HCP Coordinating Committees (which includes NMFS) would then identify additional tools to implement, prior to the next migration period, to achieve 95 percent juvenile dam passage survival and 91 percent project survival.

S.5.3.6 HCP Phases

The HCPs would be executed in three phases. Phase I would occur during the initial 5-year period (1998 – 2002). During Phase I, the PUDs should reach or demonstrate steady progress toward reaching and maintaining HCP project survival standards through implementation of protection measures. During Phase I, the PUDs would have the ultimate decision on the implementation of tools to achieve the 95 percent juvenile dam passage survival standard. The Coordinating Committees would evaluate the success of the protection measures to determine if the measures are likely to meet the survival standards. If the committees conclude that the standards will not be met, parallel actions (e.g., additional spill) can be required.

Note that the PUDs are currently working towards meeting the survival standards. If the HCPs are implemented, Phase I begins April 1, 1998 with the baseline conditions represented as 1997. This baseline would be used to assess steady progress toward achieving the survival standards over the remaining period, through 2003. Adherence to steady progress however, would not be monitored until the HCPs were actually implemented.

At the end of Phase I, the Coordinating Committees would conclude whether passage survival meets the HCP requirements. Where survival standards are met for specific dams or species, the PUDs would proceed to Phase III. For those dams and species where survival standards are not met, the PUDs would proceed to Phase II.

Phase II includes additional tools that are needed to meet the passage survival standards. The Coordinating Committees would identify the additional tools or studies that are to be implemented for the projects to meet the survival standards, using the following criteria:

1. likelihood of biological success;

2. time required to implement; and

3. cost-effectiveness of solutions, but only where two or more alternatives are comparable in their biological effectiveness.

For Phase III, where the survival standards are met for specific species, the Coordinating Committees would periodically review project survival to ensure that it is maintained according to the HCP requirements. If project survival falls below the standards during Phase III, Phase II would be reinitiated for those species.

S.5.3.7 HCP Committees

The three HCPs would be implemented through four committees:

- two Coordinating Committees,
- one Tributary Committee, and
- one Hatchery Committee.

All of the committees are represented by one member of each signatory party. Douglas County and Chelan County PUDs would have separate Coordinating Committees for the Wells and Rocky Reach/Rock Island projects, respectively. There would be one Tributary Committee and one Hatchery Committee that cover all three HCPs.

The Coordinating Committees would oversee HCP monitoring programs, and periodically evaluate the protection measures to assess actual project survival and unavoidable project mortality provided that no more than 9 percent unavoidable project mortality shall be made up through hatchery and tributary compensation. If any project, for any species, cannot obtain the 91 percent project survival (including the 95 percent juvenile dam passage survival standard), then the PUDs shall consult with the signatory parties through the Coordinating Committees to jointly seek a solution.

The Tributary Committee is charged with the task of selecting projects and approving project budgets from the Plan Species Account for purposes of implementing the Tributary Conservation Plan based on the 2 percent compensation standard.

The Hatchery Committee is responsible for evaluating the hatchery program and ensuring that adequate compensation is being maintained based on the 7 percent compensation standard.

S.5.3.8 HCP Conservation Plan and Compensation Measures

The measures described below are currently considered to be the tools that Chelan and Douglas County PUDs would use to meet the 91 percent project survival and the 95 percent juvenile dam passage survival standards.

Wells Dam

Outside of the existing mitigation measures negotiated during the 1990 long-term fisheries settlement agreement for the Wells project (FERC 1991), no new structural modifications have been identified to date. The existing juvenile fish bypass system at Wells Dam is estimated to have an overall survival rate of about 98 percent. However, Douglas County PUD would continue to work with fishery agencies and Tribes to optimize passage conditions by refining operating standards for adult fishladders and developing minor structural changes to improve ladder efficiencies. The Douglas County PUD would use its best efforts to undertake any feasible passage project measure that is biologically effective and cost efficient. A 3-year project survival study to assess reservoir and project passage survival would be funded, as well as additional studies of predator behavior and population dynamics to reduce the number of predators in the project area.

Rocky Reach Dam

The Chelan County PUD would be undertaking various interim, prototype, and permanent measures at the Rocky Reach Dam in an effort to achieve a 95 percent juvenile dam passage survival rate for juvenile salmonids migrating through the Rocky Reach forebay, dam, and tailrace. These measures would include interim spill; bypass diversion screen operations; surface collection system development, testing and installation; turbine replacement; and predator control. The appropriate mix of measures would vary as the surface collection system is improved and its efficiency tested and quantified. Survival data would determine the number, type, and magnitude of the various protective measures needed to achieve the 95 percent juvenile dam passage survival standard and an adult passage rate through the project that would meet the overall 91 percent project survival standard that includes both juveniles and adults. Actions would also be taken to improve survival and assure timely passage of adult salmonids through the project. Measures in the Rocky Reach HCP include:

- Design, model, prototype test, and install a turbine bypass system consisting of a surface collection system with or without secondary collection from a limited number of turbine intake screens.

- Modify replacement turbine runners to improve survival of juvenile salmonids as much as possible, given manufacturing, technical, and installation schedule limitations.

- Continue implementing a spill program that provides spill levels of 15 percent of the daily average flow for a 30-day period during the spring-run juvenile migration. In addition, provide up to 6 additional days of 15 percent spill to encompass 90 percent of the Okanogan sockeye run. During the summer, spill 10 percent of the daily average flow for a total of 34 days between June 15 and August 15. Spill may be adjusted or discontinued based on the relative success of other protection measures.

- Immediately initiate evaluations of spill efficiency and total dissolved gas abatement options. To the extent that spill or other spillway-type passage measures are employed at the project to achieve 95 percent juvenile fish dam passage survival and no net impact, Chelan County PUD would coordinate its use with upstream and downstream projects to address total dissolved gas levels.

- Maintain effective predator control measures.

- Perform the necessary studies to properly monitor and evaluate on-site mitigation measures.

Rock Island Dam

Similar to the Rocky Reach Project, the Chelan County PUD would undertake various interim, prototype, and permanent measures at Rock Island Dam in an effort to achieve the 95 percent dam passage survival standard for juvenile salmonids migrating through the Rock Island forebay, dam, and tailrace. These measures could include a juvenile bypass system, modified spill gates for surface spill, continued or expanded measures for predator control, and possible improvements to turbines. Survival data obtained at each step in the process would determine the number, type, and magnitude of the various protective measures needed to achieve the 95 percent juvenile dam passage survival standard. Actions would also be taken to improve survival and assure timely passage of adult salmonids through the project to meet the 91 percent project survival standard. The measures could include:

- designing, modeling, prototype testing, and installing spill gate modifications to provide surface spill to increase fish passage efficiency;
- testing and evaluating various spill configurations;
- continue implementing the existing spill program;
- designing, modeling, prototype testing, and installing a turbine bypass system consisting of a surface bypass collection system, with or without secondary collection from turbine intakes;
- possible replacement of turbine runners to improve survival of juvenile salmonids that pass through the units, and limiting use of the Powerhouse 1 turbines;
- testing a forebay guidance curtain to route juvenile anadromous salmonids into surface bypass collectors;
- maintaining effective predator control measures; and
- performing necessary studies to properly monitor and evaluate on-site mitigation measures.

Tributary Conservation Plan

Alternative 3 would create a Plan Species Account, to be used to collectively fund activities for the protection and restoration of Plan species habitat within the Columbia River watershed (from Chief Joseph tailrace to the Rock Island tailrace), and the Okanogan, Methow, Entiat and Wenatchee River watersheds, in order to compensate for 2 percent of the unavoidable project mortality. These habitat improvement projects could include, but not be limited to:

- providing access to currently blocked stream sections or oxbows,
- removing dams or other passage barriers on tributary streams,
- improving or increasing the hiding and resting cover habitat that is essential for these species during their relatively long adult holding period,
- improving in-stream flow conditions by correcting problematic water diversion or withdrawal structures, and
- purchasing important aquatic habitat shoreline areas for preservation or restoration.

Such tributary habitat conservation and restoration measures are expected to improve the migration and rearing conditions for all anadromous fish species. These measures are also expected to help decrease bank erosion, sedimentation, channel scouring and water quality problems. The improved conditions would increase the opportunities for successful spawning by facilitating the adult salmonids returning to their natal spawning areas at the proper time and in good health.

The funding levels for each project to the Plan Species Account are set in the HCPs. For the Wells project, the Douglas County PUD would make an initial contribution to the account of $991,000 (1998 dollars). If juvenile dam passage survival after three years of evaluations remains greater than or equal to 95 percent, the district will make annual payments of $88,089 (1998 dollars) throughout the HCP term or will pay $1,321,333 (equivalent to 15 years of annual payments), deducting the actual costs of bond issuance and interest. If juvenile dam passage survival is less than 95 percent, the Douglas County PUD shall contribute an additional $991,000 and increase the annual funding to $176,178, or make an up front contribution of $2,642,667 (equivalent to 15 years of annual payments in 1998 dollars), deducting the actual costs of bond issuance and interest.

For the Rocky Reach project, Chelan County PUD would fund the Plan Species Account at $229,800 annually (1998 dollars adjusted annually for inflation) for the term of the HCP.

For the Rock Island project, the Chelan County PUD would provide $485,200 annually (1998 dollars adjusted annually for inflation) to the Plan Species Account.

The Plan Species Account would be vested with the authority to expend money contributed by the PUDs for activities within the Columbia River watershed (from Chief Joseph Dam tailrace to the Rock Island tailrace), and including the Okanogan, Methow, Entiat and Wenatchee River watersheds to increase productivity of salmonids in the Mid-Columbia River area.

The identity, character, and magnitude of specific compensatory actions would be determined by the Tributary Committee, subject to the guidelines and standards of biological and economic efficiency and the financial resources available through the Plan Species Account.

The Tributary Committee would be composed of one representative of each of the signatory parties. The committee may select other expert entities, such as land and water trust/conservancy groups, to serve as additional, non-voting members of the Tributary Committee. The committee would be charged with the task of selecting projects and approving project budgets for the purposes of implementing the Tributary Conservation Plan.

The tributary habitat improvement projects would be determined on a case-by-case basis by the Tributary Committee, subject to the guidelines and standards of biological and economic efficiency and the financial resources of the Plan Species Account. The guidelines for tributary projects place the highest priority on maintaining and improving stream channel diversity and floodplain function. The projects would seek to conserve and protect riparian habitat to improve incubation and rearing conditions in tributary streams.

Hatchery Compensation Plan

A Hatchery Coordinating Committee would consist of one representative of each HCP signatory party. This committee would direct the effort required of each PUD for meeting the 7 percent hatchery compensation level. The initial estimated HCP hatchery production capacities for Plan species would be based on the average adult returns of Plan species for a baseline period, the 7 percent compensation requirements, and baseline adult/smolt survival rates for existing Mid-Columbia River hatcheries. The estimated initial production capacity shall be adjusted periodically, excepting for original inundation mitigation, to achieve and maintain no net impact to the Plan species. Adjustments to the hatchery compensation level may include reduction of production to conform with actual project mortality, as determined from monitoring and evaluation, or increases in production as the base population level increases in the recovering anadromous fish populations. Hatchery compensation may be increased either by increasing the number of fish produced or by increasing the survival of fish produced at the initial production levels.

Naturally produced coho, progeny of the reintroduction efforts, will be afforded the same protection levels (no net impact standard and 91 percent project passage survival) as for other plan species. However, until successfully reproducing populations are reestablished, there are no hatchery compensation programs required in the HCPs.

S.5.3.9 Provisions for Unknown Impacts on Other Aquatic Species

The HCPs do not include mitigation measures for non-Plan species. However, species that actively or passively pass the project, bull trout for example, may benefit from improvements at the dams (through improved fish passage conditions). Bull trout are a threatened species in the Columbia River basin, and although they occur in the project area, the extent of their occurrence and the project-related impacts are unknown. The PUDs and FERC are currently conducting informal consultation with the USFWS to assess the potential effect of project operations on bull trout.

Aquatic species that are expected to benefit from the tributary habitat improvement projects conducted under the HCPs are Pacific lamprey and resident trout species (including bull trout) that occupy the same habitats as the Plan species. However, there are no specific provisions for enhancing or protecting these species under the HCPs.

In addition to the resident fish that typically occur in the tributaries, there are no provisions in the HCPs to enhance or protect fish species that typically occur in the reservoir areas

Terrestrial wildlife species that use riparian, wetland, and floodplain habitats are expected to benefit from implementation of aquatic habitat improvements in the tributaries. These improvements should increase their food supply, cover, and overall habitat area.

S.5.3.10 Monitoring and Evaluation

All three HCPs propose monitoring and evaluation of on-site measures to determine if the 95 percent juvenile dam passage survival standard and 91 percent project survival standard have been achieved. In addition, monitoring and evaluation of tributary habitat improvements funded by the Plan Species Account and the number of fish produced by the hatchery program would also be monitored.

S.5.3.11 Project Cumulative Effects

The PUDs would notify and consider comments from the signatory parties regarding land use permit applications on project-owned lands. The PUDs would also notify applicants seeking permits to use or occupy project lands or water that such use or occupancy may result in an incidental take of species listed under the Endangered Species Act.

S.5.3.12 Costs and Funding

Funding of all on-site measures, including studies necessary to evaluate and monitor the effectiveness of those measures, would be provided directly by the PUDs from power sale revenues. It is anticipated that bonds secured by those revenues would be issued for major capital costs, such as bypass construction. Money for the Plan Species Account would also come from project revenues, with the initial contribution possibly obtained from a bond issue.

S.5.3.13 Issuance of the Incidental Take Permit

According to Section 10 (a)(2)(B) of the Endangered Species Act, after the HCPs undergo public review and comment, Section 10 incidental take permits may be issued if the agency finds that:

- any takings would be incidental;

- P the PUDs would, to the maximum extent practicable, minimize and mitigate the impacts of such takings;
- P the PUDs would ensure adequate funding of the HCPs;
- P any takings would not appreciably reduce the likelihood of the survival and recovery of the species in the wild; and
- P that other measures required by the agency through its biological opinion would be met.

S.3.5.14 Clarification of HCP Issues

The HCPs were provided to NMFS in 1998 at which time some of the preliminary provisions were implemented pending Endangered Species Act and NEPA reviews. For example, since 1998, the PUDs have had ultimate decision on pursuit and implementation of tools to achieve the juvenile dam passage survival standard. As a result, Phase I should be completed by 2003. For Douglas County PUD, evaluation to determine whether standards have been achieved at the Wells Dam occurred during Phase I. For the Chelan County PUD, the evaluation period will likely follow Phase I for the Rocky Reach and Rock Island dams. Several inconsistencies have resulted from this phased implementation approach, and a number of technical issues have arisen during the initial implementation efforts. The following sections attempt to clarify these inconsistencies and issues. The terms of the HCPs are expected to be modified as necessary to reflect these clarifications.

Term of the HCPs

Phase I would continue through 2003, although the 50-year term of the HCPs would not begin until the incidental take permits are issued. Based on the current schedule, the terms of the HCPs should be from April 2002 through March 2052. Payments to the Plan Species Account would be initiated when the incidental take permits are issued, and adjusted for inflation from 1998.

Transition Period

Because measures common to Phase 1 of the HCPs have been conditionally implemented by the PUDs (even though the HCPs have not been agreed to by all parties at this time), the PUDs have had the ultimate authority on pursuit and implementation of specific bypass measures since 1998. However, the existing FERC license articles, settlement agreements and stipulations remain in effect to address dispute resolution proceedings, spill volumes, and hatchery compensation levels. Components of the HCPs that address each of these issues would not be implemented until the agreements have been ratified. In order to address ongoing Endangered Species Act issues, FERC and NMFS have been consulting over interim protection plans that would remain in affect until April 2002, or until the HCPs are ratified (whichever comes first). If the agreements have not been ratified by April 2002, FERC would be required to reinitiate consultation with NMFS under Section 7 of the Endangered Species Act at which time additional measures may be required.

Verification of Standards

In order to determine if the HCPs survival standards are being met, specific biological and statistical standards have been established in the HCPs. These standards apply to all of the evaluations to be conducted. Because the available technology is not sufficient to adequately conduct all of the evaluations proposed in the HCPs for each of the Plan species, representative survival studies would be conducted for yearling chinook salmon and steelhead. Indirect methods of measuring compliance would be developed for each of the remaining plan species. The results would be utilized to support decisions made under Phase I of the HCPs and efforts to determine more direct compliance with the standards for all species would continue during phases II and III. Survival studies of yearling chinook salmon and steelhead were initiated at the Wells Project in 1998 and will be initiated at the Rocky Reach and Rock Island projects by no later than 2003. Initial verification of the 95 percent juvenile dam passage survival standard is expected to take 3 years.

Currently, the 95 percent juvenile dam passage survival standard cannot be verified for subyearling chinook (summer/fall chinook) or for sockeye salmon and the 91 percent total project survival standard (which includes the survival of the adult life stages) cannot be verified for any of the Plan species. There is currently no methodology that all parties support for determining the survival of adult fish through the projects. Therefore, information pertaining to the juvenile life stages and compliance with the juvenile dam passage survival standards will be the basis for determining if the standards have been met.

The HCPs provide a mechanism for future verification of the 91 percent total project survival standards for each of the Plan species, as the appropriate technology is developed and supported by the Coordinating Committees.

Wells Project

Because the Wells Project has an existing bypass system, juvenile survival studies were initiated before the end of the Phase I time frame. Douglas County PUD conducted juvenile survival studies in 1998 using yearling chinook salmon, and in 1999 and 2000 using yearling steelhead. Although not required under Phase I of the HCP, it is anticipated that a fourth year of juvenile survival studies will be conducted in 2001, using yearling chinook salmon. Additionally, the Douglas County PUD conducted 3 years of fish passage efficiency evaluations (an estimate of the number of juvenile fish bypassing the project through the surface bypass system) for the Wells project bypass system. These studies indicated that 92 percent of the spring-run migrants (yearling chinook, steelhead, and sockeye) and 96 percent of the summer-run migrants (summer/fall chinook) use the bypass system. Based on the best estimate of turbine and bypass survival (91.2 and 98 percent, respectively), spring-run migrants are expected to have a juvenile dam passage survival rate of 97.5 percent and summer-run migrants are expected to have a 97.7 percent juvenile dam passage survival rate.

The determination of whether the Wells project is meeting the HCP survival standards will initially be based upon the results of the project survival studies conducted for yearling chinook salmon and steelhead, and an indirect assessment of juvenile survival for each of the remaining Plan species. Throughout the term of the HCP, the 95 percent juvenile dam passage survival standard and the 91 percent total project survival standard would be re-evaluated from time to time as determined necessary by the Coordinating Committee. It is anticipated that, as technology is developed; sockeye and subyearling chinook salmon, as well as adult salmon, and steelhead survival studies would be conducted.

Funding for the Tributary Conservation Plan for the Wells project is tied directly to the survival standards. If it is determined that the Wells total project survival standard is equal to or more than 95 percent, Douglas County PUD’s contribution to the tributary fund will be one-half of the expected contribution. If the total project survival standard is determined to fall below 95 percent, Douglas County PUD will contribute prospectively, for the remaining time of the HCP, the equivalent of a full 2 percent credit to the tributary fund. Until the Coordinating Committee develops methodologies to evaluate the adult project passage survival component of the total project survival standard, the results of the juvenile survival studies (including both the direct and indirect effects of dam and reservoir related survival) will singularly determine Douglas County PUD’s contribution to the Plan Species Account. Therefore, if 95 percent juvenile project survival is met, the fund will be one-half of the expected contribution.

Rocky Reach Project

The Chelan County PUD is developing a surface bypass collector system for the Rocky Reach project. At the conclusion of Phase I, or earlier if the Coordinating Committee concurs, Chelan County PUD will initiate 3 years of survival studies for yearling chinook salmon and steelhead to verify that the 95 percent juvenile dam passage survival standard is being met. As is the case with the Wells

Project, the best available information will be used to determine whether the juvenile dam passage survival standard has been met for each of the remaining Plan species (e.g., survival information from surrogate species combined with measurements of fish passage through non turbine routes). Throughout the term of the HCP, the 95 percent juvenile dam passage survival standard and the 91 percent total project survival standard will be re-evaluated from time to time as determined necessary by the Coordinating Committee.

Rock Island Project

Spill is currently the preferred juvenile bypass measure at Rock Island Dam. At the end of Phase I (or earlier if the Coordinating Committee concurs) Chelan County PUD will initiate 3 years of survival studies for yearling chinook salmon and steelhead to verify that the 95 percent juvenile dam passage survival standard is being met. As is the case with the Wells and Rocky Reach projects, the best available information will be used to determine whether the juvenile dam passage survival standard has been met for each of the remaining Plan species (e.g., survival information from surrogate species combined with measurements of fish passage through non turbine routes). Throughout the term of the HCP, the 95 percent juvenile dam passage survival standard and the 91 percent project survival standard will be re-evaluated from time to time as determined necessary by the Coordinating Committee.

Compensation for Unavoidable Project Mortality

During the development of this EIS, certain sections of the HCPs required clarification to allow for accurate analysis of the potential affects of the actions on Endangered Species Act-listed species and on other natural resources. Most of the clarifications related specifically to modification of the standards to ensure no net impact. It should be noted that HCP survival standards are fixed and compensation will not vary if the standards are not being met. Hatchery compensation would not be increased to 9 percent; for example, if dam passage survival is only 93 percent for a given species. The 2 percent shortcoming in the juvenile dam passage survival standard would be addressed through improvements in dam passage survival. Likewise, if the 7 percent hatchery compensation level is not met due to NMFS Endangered Species Act concerns, neither the dam passage survival standard, the project survival standard, nor the habitat compensation standard would be adjusted.

Hatchery Compensation Plan Issue

During the development of the HCPs, NMFS determined that the 7 percent hatchery compensation levels may adversely affect wild salmon populations under certain conditions. For example, it may be necessary to use adult salmon and steelhead that are not adapted to the local habitat conditions in order to produce enough juvenile fish to meet the 7 percent compensation level. In order to ensure that these compensation levels do not affect the long-term health of the wild populations, all fish produced under this program must be from local stocks. Therefore, until the specific details of the compensation programs are developed, including identification of appropriate broodstock, maximum percentages of the wild populations that can be trapped for broodstock, and the total number of fish produced through artificial means, NMFS can not guarantee that the 7 percent compensation level will satisfy Endangered Species Act requirements and no net impact would not be achieved.

Although several of the affected Columbia basin treaty Tribes made significant comments during the scoping process associated with this EIS, a major concern was NMFS' reluctance to guarantee the 7 percent compensation levels. These levels were a key component of achieving and maintaining no net impact and a crucial portion of tribal consideration for the HCPs. Without a guarantee from NMFS that the 7 percent compensation levels would be attained, the Tribes will not endorse the HCPs.

S.5.3.15 Recent HCP Revisions

On June 1, 2000, the USFWS and NMFS published a final addendum to the Handbook for Habitat Conservation Planning and Incidental Take

Permitting Process. This addendum, which is also known as the five-point policy guidance, provides clarifying direction on five issues brought forth from recent HCPs implemented throughout the United States. Described below is how the applicant HCPs meet the HCP addendum.

Biological Goals and Objectives

The addendum recommends that biological goals and objectives be incorporated in HCPs. These goals may be either habitat or species based. Species-based goals are expressed in terms specific to individuals or populations of that species. The performance standards identified in Section S.5.3.5 represent the biological goals and objectives for the HCPs (i.e., the HCP standards). These standards require specific survival goals based on the population passing through each project. In addition, incidental mortality is mitigated through hatchery production and habitat improvements to achieve an overall no net impact standard.

Adaptive Management

The use of an adaptive management strategy is recommended to: (1) identify the uncertainties related to quantifying the achievement of goals and objectives of the HCPs as well as the questions that need to be addressed to resolve these uncertainties; (2) develop alternative strategies and determine which experimental strategies to implement; (3) integrate a monitoring program that is able to detect the necessary information for strategy evaluation; and (4) incorporate feedback loops that link implementation and monitoring to a decision-making process that results in appropriate changes in management. Adaptive management would be incorporated into the HCP monitoring programs that provide the feedback necessary to determine the effectiveness of various approaches being implemented to increase fish survival. Throughout the term of the HCP, what is learned would be used to adjust conservation measures.

Monitoring

HCP handbook guidance on monitoring recommends that the monitoring program reflect the measurable biological standards and objectives. The monitoring programs developed under the HCPs are two-fold: (1) to confirm fish survival through the dams, and (2) evaluate the effectiveness of on-site mitigation measures implemented to improve fish survival.

Permit Duration

Factors to be evaluated when determining permit duration include the time line of the proposed activities and the expected positive and negative effects on covered species associated with the proposed duration. The HCP terms generally compliment the term of a project operating license, but more importantly reflect a desire to provide long-term protection assurances for the Plan species that also account for oceanic condition changes that may occur over a longer period of time.

Public Participation

The HCP handbook amendment recommends a 90-day public comment period for large-scale, regional, or complex HCPs. The public review period for the Wells, Rocky Reach, and Rock Island HCPs will occur over a 90-day period.

S.6 ACTIONS COMMON TO ALL ALTERNATIVES

Only those project operations that affect fish passage would be altered, if necessary, to assist in increasing the overall salmon and steelhead survival rates. Studies to evaluate and improve fish passage have been ongoing since the dams were constructed. As a result, the key factors influencing fish passage have already been identified. Project operations that are included under all of the alternatives are:

- fishways,
- fishladders,
- fish bypass,
- turbine operations,
- predator removal,
- hatcheries, and
- spill.

The four tributaries where funds for the Plan Species Account would be directed under the HCP (Wenatchee, Entiat, Methow, and Okanogan) have threatened (bull trout) and endangered (spring-run chinook and steelhead) species. Numerous efforts are being, or will be, implemented to improve fish survival and breeding opportunities in the streams that are unrelated to the operation of the Wells, Rocky Reach, and Rock Island dams or the HCPs. These improvement activities would continue under all alternatives.

S.7 ALTERNATIVE COMPARISON

Because each of the alternatives strive to improve fish survival at the dams, environmental differences among the alternatives at the project site are somewhat less significant than the procedural differences between Endangered Species Act Section 7 consultations (Alternative 2) and Section 10 permit processes (Alternative 3) as shown in Table S-2 and described below.

The most significant differences among the alternatives are the scope of the species covered, the statutory obligations covered, the parties that support each alternatives, and the speed at which each alternative could be implemented. Alternative 1, current FERC license requirements, addresses all species but may or may not address the additional requirements of the Endangered Species Act. Alternative 2 creates a long-term protection plan between FERC and NMFS only for listed upper Columbia River steelhead and spring-run chinook salmon and requires a new consultation at the time each project is re-licensed. Measures under Alternative 2 are not currently supported by FERC or the licensees, which may lead to a delay in implementing actions. Alternative 3, the HCPs, are long-term settlements of salmon and steelhead issues at each project under the current license and at relicensing. The settlements cover statutory obligations in addition to the ESA, and apply to any party that signs the HCP agreements. The HCPs were initially developed by the PUDs along with NMFS; FERC; USFWS; the Yakama, Colville, and Umatilla Tribes; American Rivers, Inc.; and each project's wholesale power purchasers.

Table S-2 compares the alternatives, and the text in Sections S.7.1 through S.7.6 below describes the major differences between the alternatives. Note that the following information is not intended to identify every possible scenario that may result under each alternative, only to address the major procedural differences in the alternatives, and to highlight some of the fundamental protection differences.

S.7.1 AFFECTED SPECIES

S.7.1.1 Alternative 1 (No Action)

Protection for the listed and non-listed anadromous salmonid species would be provided through the existing FERC licenses (and future relicensing procedures). Existing measures however, may not prevent the extinction of listed species. Additional Federal laws, primarily the Federal Power Act, could be utilized to seek protection, mitigation, and enhancement measures for steelhead, spring-run chinook salmon, summer/fall chinook salmon, and sockeye salmon during project relicensings and through license re-opener clauses.

TABLE S-2. ALTERNATIVE COMPARISON

ACTION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Endangered Species Act Compliance	None	Section 7 (a)(2)	Section 10 (a)(1)
Duration of each Alternative	Not applicable	Current license term, modified as needed based on new information – consultation reinitiated at relicensing	50 years subject to withdrawal and termination provisions
Species Covered	Anadromous fish in general	Upper Columbia spring-run chinook Upper Columbia steelhead (Permit species)	Spring-run, summer and fall chinook, summer steelhead, sockeye salmon, and coho salmon (Plan species)
Protection Measures	Limited spill and bypass measures, continued operation of adult fishways	Additional project operational and structural modifications for listed species only and habitat improvements if necessary to prevent the extinction of listed species	Additional project operational and structural modifications for all Plan species and immediate implementation of habitat improvement measures
Performance Standards	Currently based on fish passage efficiency for specific measures (no project or species level standards)	The species' persistence, as listed or as a recovery unit, beyond the conditions leading to its endangerment, with sufficient resilience to allow for the potential recovery from endangerment	No Net Impact - 91% overall fish passage survival (juvenile and adult) with an independent standard of 95% juvenile survival through the forebay, dam and tailrace. Compensation to obtain no net impact also includes 7% to hatchery programs and 2% to tributary programs
Project Lead for Identifying and Implementing Protection Measures	FERC	FERC in consultation with NMFS	HCP Coordinating Committees
Location of Fish Protection Measures	Area of project including reservoir, dam structures, tailrace, and hatcheries	Area of project including reservoir, dam structures, tailrace, and hatcheries. Tributary improvements may be proposed if necessary to prevent the extinction of listed species	Area of project including reservoir, dam structures, tailrace, and hatcheries and additionally includes Wenatchee, Entiat, Methow, and Okanogan rivers and tributaries, as well as associated hatcheries and agreement on the habitat improvement process
No Surprises Policy	Not applicable	Not applicable	Applicable
Continued Studies to Assess Survival	Yes for Wells, but only to verify fish passage measures at Rock Island and Rocky Reach	Yes	Yes

TABLE S-2. ALTERNATIVE COMPARISON (CONTINUED)

ACTION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Monitoring Following Statement/Permit Issuance	Limited	As needed to ensure effectiveness of measures and status of listed species	Significant throughout the term of the agreement for all Plan species
Future Provisions for Other Aquatic Species	Would occur under relicensing or under existing license reopener clauses	Same as Alternative 1	Same as Alternative 1
Hatchery Compensation	Continued hatchery funding at present level, for inundation compensation levels and ongoing unavoidable losses (hatchery compensation can be adjusted for Wells base on actual losses)	Same as Alternative 1, although may be refined based on effects to listed species	Continued hatchery funding for inundation compensation levels. Hatchery funding for ongoing unavoidable losses would be set to achieve 7 percent compensation levels, unless reduced to prevent jeopardy to listed species
Tributary Improvements	No PUD-funded improvements	Potentially, if necessary to prevent the extinction of listed species (implemented in lieu of non-power measures)	PUD contributions to the Plan Species Account would pay for projects that improve salmon and steelhead habitat in the Wenatchee, Entiat, Methow, and Okanogan river basins, as well as the Mid-Columbia River mainstem. Monetary amount is specified in the HCPs
On-Site Protection Measures			
Wells	Adult Passage: Continue operation and maintenance of adult fishways, evaluate and improve fishway operations, conduct modeling and develop solutions for adult fish passage problems, use spillway flow configurations to optimize adult fishway attraction flows	Adult Passage: Same as Alternative 1 or as needed to prevent the extinction of listed species	Adult Passage: Meet 91% overall survival standards (including juvenile and adults) for all Plan species
	Juvenile Passage: Evaluate and control total dissolved gas, continue predator control program. Operate surface bypass system 24-hours/day to achieve 70-80% FPE	Juvenile Passage: In addition to measures in Alternative 1: Operate turbines at peak efficiency ratings, operate surface bypass system 24 hours/day for 95% of juvenile spring-run chinook and steelhead migrations, increase spill as needed to prevent the extinction of listed species	Juvenile Passage: Meet 95% dam passage survival for all Plan species by increasing effectiveness of juvenile bypass system, spill gates, predator control, and turbine usage. Applicant has opportunity of selecting options that, when combined, meet survival standards

TABLE S-2. ALTERNATIVE COMPARISON (CONTINUED)

ACTION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Rocky Reach	Adult Passage: Continue to operate and maintain adult fishladders	Adult Passage: Continue operation and maintenance of adult fishways, evaluate and improve fishway operations, conduct modeling and develop solutions for adult fish passage problems, use spillway flow configurations to optimize adult fishway attraction flows	Adult Passage: Same as Wells (above)
	Juvenile Passage: Spill 15% of daily river flow for up to 30 days during spring migration period and 10% for 34 days during the summer migration, evaluate and construct a permanent bypass system and replace old turbine runners	Juvenile Passage: In addition to measures identified in Alternative 1, increase spill as necessary to prevent the extinction of listed species	Juvenile Passage: Same as Wells (above)
Rock Island	Adult Passage: Continue to operate and maintain adult fishladders	Adult Passage: Same as for Rocky Reach (above)	Adult Passage: Same as Wells (above)
	Juvenile Passage: Provide spill as requested by fish agencies and Tribes through the a Fish Conservation Account	Juvenile Passage: In addition to measures identified in Alternative 1, increase spill as necessary to prevent the extinction of listed species, enhance spillway passage efficiency, preferentially use Powerhouse 2 turbines, and minimize use of Nagler turbines	Juvenile Passage: Same as Wells (above)
Dispute Resolution	Disputes resolved by FERC and/or in court	Disputes are resolved by NMFS, FERC and/or in court	Disputes resolved by mediation and binding arbitration, and includes expedited dispute resolution procedures to resolve some disputes within 30 days
		Other measures as required by NMFS to ensure protection and recovery of the listed species	

S.7.1.2 Alternative 2

Authorities afforded to NMFS under the Endangered Species Act would apply to upper Columbia River steelhead, upper Columbia River spring-run chinook salmon, and Mid-Columbia River steelhead. Protection, mitigation, and enhancement measures for summer/fall chinook and sockeye salmon would be addressed as in Alternative 1.

S.7.1.3 Alternative 3

The HCP applies to: upper Columbia River steelhead, upper Columbia River spring-run chinook salmon, sockeye salmon, summer/fall chinook salmon, and coho salmon (although the wild population of coho salmon has been extirpated from the action area, the HCPs provide measures to protect reintroduced populations). Although the impacts to Mid-Columbia River steelhead are likely limited to water quality issues, this species is not specifically addressed in the HCP agreements.

S.7.2 PROCEDURAL DIFFERENCES

S.7.2.1 Alternative 1 (No Action)

Provisions of this alternative would be implemented through FERC proceedings, which currently include use of Coordinating Committees. The committees consist of members representing fishery agencies, Tribes, and PUDs. The protection measures implemented through this process require unanimous consent of all parties. This can, and has resulted in contested proceedings and legal debates among the parties that have significantly delayed implementation of fish protection measures. This alternative does not provide direct protection for listed species, and therefore may not necessarily satisfy Endangered Species Act requirements.

S.7.2.2 Alternative 2

Under Alternative 2 (Endangered Species Act Section 7 consultations for listed species), NMFS has the legal authority to determine the actions necessary to ensure the survival and recovery of listed species. This includes:

- determining the most appropriate measures to be taken at each project,
- determining the necessary level of survival at each project,
- determining the most appropriate data to be considered when evaluating survival,
- and modifying the measures as needed if species continue to decline.

The FERC, as the action agency, must comply with these actions in order to be exempt from the take prohibitions as described under Section 9 of the Endangered Species Act. Under Section 7, NMFS has a legal responsibility to provide the benefit of the doubt to listed species with respect to gaps in the information base.

If FERC or the PUDs disagree with NMFS' decisions under this process, lengthy legal proceedings may ensue. During these proceedings, measures in addition to those already included in the FERC-issued operating licenses and settlement agreements are not likely to be implemented.

Species not listed under the Endangered Species Act would be addressed as in Alternative 1.

S.7.2.3 Alternative 3

According to provisions in the HCPs, the authority to determine the appropriate protection measures for all of the Plan species, including the Endangered Species Act-listed species, fundamentally shifts away from NMFS under Alternative 3 (HCPs) once the incidental take permit has been issued. During Phase I of the HCPs, the PUDs would have the ultimate authority to determine the measures necessary to achieve the survival standards. During Phase II, a Coordinating Committee (comprised of the PUD responsible for the HCP, NMFS, and each of the signatories to the agreement) jointly decides on the appropriate measures. If the Coordinating Committee cannot reach consensus, the PUDs may continue to determine the appropriate measures unless the matter is addressed through the dispute resolution process.

The party bringing an issue to dispute resolution must prove its case by a preponderance of the evidence. There is no requirement to provide the benefit of the doubt to the species of concern with respect to gaps in the information base and NMFS has no authority to determine what constitutes the best available information to be utilized in support of any decisions. The dispute resolution process is limited to under five months, ensuring that lengthy legal disputes would not occur, and decisions reached through the dispute resolution process are binding. As a result, specific measures are likely to be implemented more expeditiously than could be expected under Alternative 2. If the standards are achieved by 2003, they would be maintained by the PUDs throughout the term of the agreement.

Because the HCPs set out certain actions, responsibilities, and duties to be carried out by the PUDs, each of the signatories to the agreements agrees not to institute any action under the Endangered Species Act, the Federal Power Act, the Fish and Wildlife Coordination Act, or the Pacific Northwest Electric Power Planning Conservation Act. In addition, NMFS' no surprises policy (which ensures the PUDs that NMFS would not request additional measures during the term of this agreement) would be in effect.

S.7.3 TIME FRAME

S.7.3.1 Alternative 1 (No Action)

Fish protection measures included in this alternative would occur throughout the term of the FERC-issued operating licenses. They may not, however, represent sufficient protection for Endangered Species Act-listed species. In any case, project operations would continue as occurs presently regardless of future listings or delisting. FERC license periods are typically 30 to 50 years, although the three Wells, Rocky Reach, and Rock Island projects would be relicensed over the next 29 years. Additional fish protection measures would likely be implemented during relicensing.

S.7.3.2 Alternative 2

Specific measures required for Endangered Species Act-listed species would be in effect throughout the term of the FERC-issued operating licenses or until the species status warranted delisting. FERC would be required to reconsult under Section 7 of the Endangered Species Act prior to issuing any new project operating licenses or amendments (measures initiated under the Federal Power Act for unlisted species would be in effect through the FERC license period [typically 30 to 50 years]). Section 7 consultation would be reinitiated, and additional measures potentially required, as new information is developed under the research and monitoring programs.

S.7.3.3 Alternative 3

The HCPs would be in effect for a 50-year period beginning with the date that the agreements are legally ratified by each of the signatories (currently expected to be April 2002 through March 2052).

S.7.4 GOALS AND OBJECTIVES

S.7.4.1 Alternative 1 (No Action)

This alternative may not provide specific provisions to ensure the continued existence or recovery of Endangered Species Act-listed fish species. Protection measures would continue to be implemented in accordance with existing FERC license articles and settlement agreements. Goals and objectives tend to be specific for each measure at each dam (i.e., no project or species level standards).

S.7.4.2 Alternative 2

The Endangered Species Act Section 7 process is specifically intended to ensure the continued existence of listed species with an adequate potential for recovery. The manner in which the projects are operated is based upon a biological opinion issued by NMFS to FERC, and a FERC order issued to the PUDs.

S.7.4.3 Alternative 3

The HCPs guarantee 100 percent no net impact for all of the Plan species.

S.7.5 ADDITIONAL MEASURES

S.7.5.1 Alternative 1 (No Action)

This alternative does not provide a procedure to force implementation of mitigation measures beyond the project's boundaries (i.e., tributary habitat improvements). Under Alternative 1, hatchery supplementation is addressed through the existing settlement agreements between FERC and the PUDs, the existing license articles, or through the relicensing procedures.

S.7.5.2 Alternative 2

The Endangered Species Act Section 7 process typically does not address off site mitigation (i.e., habitat improvement) that has not been affected by the proposed action. However, NMFS would likely propose offsite actions prior to investigating any non-power measures, if protection measures implemented at the projects have been fully utilized and the species continue to decline. Under Alternative 2, supplementation is addressed through the existing settlement agreements between FERC and the PUDs or during relicensing. If NMFS determines that the current hatchery production levels will compromise the genetic integrity of wild fish, the production levels would be reduced.

S.7.5.3 Alternative 3

The HCPs include a funding process for the protection and restoration of Plan species' habitat within the Columbia River watershed (from the Chief Joseph Project tailrace to the Rock Island Project tailrace) and in the Okanogan, Methow, Entiat, and Wenatchee River watersheds. In addition, hatchery compensation plans guarantee funding and capacity to meet the 7 percent compensation level necessary to achieve no net impact.

S.7.6 OTHER ENVIRONMENTAL MEASURES

Table S-3 provides a summary comparison of how the proposed fish protection measures affect other environmental resources in the project area.

S.8 DECISION TO BE MADE

The proposed action (Alternative 3) is the preferred alternative by the project proponents (Douglas County and Chelan County PUDs). NMFS will select the Federal agency's preferred alternative in a Record of Decision (ROD) that will be issued by NMFS after the completion of this EIS and following the subsequent public review and comment period. There are several key steps that NMFS must also take before deciding on the applicants' request for a Section 10 incidental take permit. The actions by NMFS will be guided by both the Endangered Species Act and NEPA requirements. The major NEPA-related issues that NMFS must consider in making its decision are:

- Was the environmental review process adequate?

- Were the impacts adequately discussed, and will significant adverse impacts be mitigated?
- Were all reasonable and appropriate alternatives to the proposed action considered?
- Are there significant unavoidable adverse impacts?
- What were the values that were considered, and what is the basis for the decision?
- Are there any outstanding unresolved issue?
- Will the proposed action result in the irrevocable commitment of Federal resources?

The major Endangered Species Act issues that NMFS must consider are related to the overall protection and recovery of the salmon and steelhead species that would be covered by the incidental take permit. To document its analysis and decision making, NMFS will prepare a biological opinion to determine if the implementation of the HCPs is likely to jeopardize the continued existence of listed species that are likely to occur in the Plan area. The analysis by NMFS will involve:

- defining the species-level biological requirements,
- evaluating the species status with respect to the species-level biological requirements,
- determining the biological requirements within the proposed action area,
- determining the status of the species within the action area,
- determining the factors affecting the species environment within the action area,
- determining the effects of the proposed action on species-level biological requirements,
- evaluating the cumulative effects associated with the proposed action,
- identifying critical habitat for the species,
- determining whether the species can be expected to survive with an adequate potential for recovery under the proposed action, and
- identifying reasonable alternatives to the proposed action if it is likely to jeopardize listed species.

If the NMFS' biological opinion finds that the proposed actions are not likely to jeopardize the continued existence of the listed species and not likely to result in the destruction or adverse modification of critical habitat, the permits can be approved. Any additional measures that NMFS deems necessary for the permit would be detailed in the biological opinion. The ROD can include the decision on the EIS, concurrent with the notice of the biological opinion and the notice of permit approval. It will certify the adequacy of the HCPs environmental review process, and it will incorporate the requirements of the permit, including the requirements in the biological opinion and the mitigation commitments of the applicants. It will also include a summary of the responses to comments on the EIS.

Alternatively, if incidental take permits are not authorized under Section 10 (a)(1)(B) of the Endangered Species Act, the FERC may seek coverage from Section 9 take prohibitions through consultation with NMFS or the PUDs may challenge NMFS' decision or file new Section 10 permit applications.

TABLE S-3. ENVIRONMENTAL COMPARISONS OF THE ALTERNATIVES (PAGE 1 OF 8)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Land Features, Geology, and Soils			
Project Area Soils	Same as existing conditions	Same as Alternative 1. If reservoir drawdown occurs, river cross sectional areas would decrease to the original size of reservoirs	Same as Alternative 2
Reservoir Erosion and Sedimentation	Same as existing conditions	Same as Alternative 1. If reservoir drawdown occurs, erosion and reservoir turbidity would initially increase over the short term and damage aquatic habitat conditions with the greatest damage occurring the first 4 to 7 years. Turbidity would decrease over time and habitat conditions would improve	Same as Alternative 2
Tributary Channel and Watershed Conditions	Geologic conditions conducive to fish habitat are expected to improve from independent local and State funded fish habitat enhancement projects	Same as Alternative 1. If reservoir drawdown occurs, tributary channel mouths would erode each year, over the first 7 years	Same as Alternative 2 with additional improvements to stream geomorphic conditions through the PUD-funded programs
Columbia River System	Same as existing conditions	Same as Alternative 1. If reservoir drawdown occurs, increased sediment and turbidity over the short term	Same as Alternative 2
Fisheries Resources: Threatened and Endangered Species (spring-run chinook, steelhead, and bull trout)			
Juvenile Migration/Survival Standards	Project specific standards, no specific protection measures for threatened or endangered species **Wells Dam**: Provide a non-turbine passage route (juvenile bypass system) to pass at least 80% of spring-run outmigrants and 70% of summer outmigrants **Rocky Reach Dam:** Provide safe (less than 2 percent mortality) non-turbine passage route (juvenile bypass or spillway passage) for 80% of juvenile migrants over 90% of the migration period	As required to recover the listed species	No Net Impact - 91% overall fish passage survival (juvenile and adult) with an independent standard of 95% juvenile survival through the forebay, dam and tailrace. Compensation to obtain no net impact also includes 7% to hatchery programs and 2% to tributary programs

TABLE S-3. ENVIRONMENTAL COMPARISONS OF THE ALTERNATIVES (PAGE 2 OF 8)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Juvenile Migration/Survival Standards (continued)	**Rock Island Dam:** Fund an account to purchase spill at the requested by fish agencies and Tribes to an annual revenue loss of $2.05 million		
Adult Migration/ Survival Standards	Maintain and operate fishladders according to criteria established by the fishery agencies	As required to recover the listed species	No Net Impact - 91% overall fish passage survival (juvenile and adult) with an independent standard of 95% juvenile survival through the forebay, dam and tailrace. Compensation to obtain No Net Impact also includes 7% to hatchery programs and 2% to tributary programs
Hatchery Production	Hatchery for initial loss of habitat when dams were constructed would continue over the long term. Hatchery funding for unavoidable continuing losses from fish passage would be refined and based on ongoing survival studies.	Same as Alternative 1, provided there are no impacts to listed species	Same as Alternative 1, except the production levels would be based on compensating for 7% of unavoidable project passage mortality. Exact amounts of fish produced are based upon the actual numbers of returning adults. Hatchery production would not be less than that specified to address project inundation
Tributary Habitat Improvements	Habitat improvements would occur through the implementation of non-PUD funded projects through Federal, State and local agency funding	Same as Alternative 1, although programs may be proposed in lieu of non-power measures if necessary to prevent the extinction of listed species	Same as Alternative 1 and additional funding provided through the HCPs to compensate for 2% of the unavoidable project mortality
Monitoring	At Wells, run timing and system efficiency monitoring would occur. At Rocky Reach and Rock Island, only monitoring to ensure facility modifications are achieving criteria identified in license articles, settlements, and stipulations	Survival studies for Endangered Species Act- listed juveniles and adults, total dissolved gas monitoring, facility evaluations and modifications	Studies necessary to ensure standards are being met for all species during phase I, periodic monitoring to ensure standards continue to be met during phase III
Drawdown	Drawdown can not be required under existing licenses	Drawdown is expected to increase survival rates of migrating juvenile fish over the long-term. However, lower water levels could initially increase predator density and predator/prey encounters. Over the short term, drawdown would decrease water quality, fish habitat, and foraging opportunities; and likely affect survival rates. Only an option at relicensing	Same as Alternative 2, although could be implemented by the PUDs anytime during the term of the agreement

TABLE S-3. ENVIRONMENTAL COMPARISONS OF THE ALTERNATIVES (PAGE 3 OF 8)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Bull trout	Bull trout could benefit from dam protection measures and tributary habitat improvements but no studies have been conducted to date to confirm effects of existing project operations	Same as Alternative 1	Same as Alternative 1
QAR RESULTS	Based on run reconstructions from the late 1970s through the mid 1990s, the return rates for upper Columbia River spring-run chinook salmon have been trending down at a loss rate of 5 to 10 percent per year. Although complicated by hatchery influences, wild steelhead return rates on the Wenatchee and Entiat Rivers are comparable to those identified for spring-run chinook salmon, but are trending downward at a faster rate on the Methow	Although maximizing survival at each of the PUD dams will increase the return rates of spring-run chinook salmon and steelhead, populations will continue to decline without reductions in non-hydro system related impacts, although at a slower rate than Alternative 1. Under the best case scenario, (i.e., maximizing survival through the hydro system [to levels at or above those defined in the HCPs] with high survival during the ocean life stages of salmon and steelhead) the risk of extinction would be reduced to acceptable levels	Achieving the project survival and habitat improvement standards identified in the proposed HCPs will increase Mid-Columbia River reach survival by approximately 22-35 percent for steelhead and 27-45 percent for spring-run chinook salmon. Under these survival rates, populations will continue to decline without reductions in non-hydro system related impacts. Commitments to habitat productivity, in addition to dam passage survival increases, will increase survival rates by approximately 6-10 percent over Alternative 2. Under the best case scenario, achieving the survival standards in the HCPs alone would reduce the risk of extinction to acceptable levels. (The effects of long-term supplementation have not been analyzed.)
<u>Fisheries Resources: Other Plan Species (summer and fall chinook sockeye, and coho)</u>			
Juvenile Migration/Survival	Same as discussed for threatened and endangered species above	Same as Alternative 1	Same as discussed for threatened and endangered species
Adult Migration/Survival	Same as discussed for threatened and endangered species above	Same as Alternative 1	Same as discussed for threatened and endangered species
Adult Reservoir Spawning	Same as discussed for threatened and endangered species above	Same as Alternative 1, unless reservoir drawdown occurs	Same as Alternative 2
Hatchery Production	Same as discussed for threatened and endangered species above	Same as Alternative 1	Same as discussed for threatened and endangered species

TABLE S-3. ENVIRONMENTAL COMPARISONS OF THE ALTERNATIVES (PAGE 4 OF 8)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Tributary Habitat Improvements	Habitat improvements would occur through the implementation of non-PUD funded projects through Federal, State and local agency funding	Same as Alternative 1	Same as Alternative 1 and additional funding provided through the HCPs to compensate for 2% of the unavoidable project mortality
Monitoring	Same as discussed for threatened and endangered species above	Same as Alternative 1	Survival studies would occur for all Plan species
Drawdown	Drawdown not proposed	Drawdown would increase spawning opportunities for fall chinook and increase migrating juvenile salmonid survival rates over the long term. However, lower water levels could increase predator density and predator/prey encounters. Over the short term, the resulting decreased water quality would affect fish habitat and foraging opportunities which would likely affect survival rates	Same as Alternative 2
<u>**Water Quantity**</u>			
Project Area Flows	No change in flows	Amount of spill could increase if necessary to prevent the extinction of listed species	Amount of spill could change dependent on efficiency of juvenile bypass systems and/or meeting the survival standards. However, water quantities would not be substantially altered
Reservoir Drawdown	Drawdown not proposed	Drawdown would increase water velocity	Same as Alternative 2
Tributary Flows	No effect	Same as Alternative 1, unless off site measures occurred to prevent the extinction of listed species	Same as Alternative 2, although additional funding would likely provide for more water conservation projects and more improvements in tributary flows
Columbia River System	No changes expected over existing conditions	Same as Alternative 1	Same as Alternative 1

TABLE S-3. ENVIRONMENTAL COMPARISONS OF THE ALTERNATIVES (PAGE 5 OF 8)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Water Quality			
Project Area Total Dissolved Gas	Some improvement expected as the Washington Department of Ecology (WDOE) imposes total maximum daily load limits for Clean Water Act compliance and other measures (e.g., spill deflectors) are implemented	Same as Alternative 1 although spill could increase if needed to prevent the extinction of listed species	Same as Alternative 1, although spill could increase as needed to meet survival standards resulting in an increase in total dissolved gas levels. However, the PUDs agreed to take measures to maintaining total gas levels at or below legal maximum levels
Tributary Water Quality	There is potential for incremental water quality improvements (e.g., higher dissolved oxygen, lower turbidity and sedimentation) as total maximum daily load program and other ongoing watershed restoration efforts proceed, and benefits from improved riparian protections are seen (no change from existing conditions)	Same as Alternative 1, although if proposed in lieu of non-power operations to prevent the extinction of listed species, restoration projects may improve tributary water quality	Same as Alternative 1, although guaranteed PUD funding would provide for more restoration projects and improvements in tributary water quality
Columbia River System Total Dissolved Gas	May be some marginal reduction in downstream total dissolved gas levels with improvements in project area total dissolved gas	Same as Alternative 1	Same as Alternative 1
Vegetation			
Project Area	No change from existing conditions	Same as Alternative 1. If reservoir drawdown occurs, it could impact shoreline and aquatic vegetation. One threatened plant species (giant hellborine) could potentially be affected by a drawdown and may require additional Endangered Species Act consultation	Same as Alternative 2
Associated Tributaries	Local and State fish habitat improvement projects are expected to improve riparian vegetation – no change from existing conditions	Same as Alternative 1	Same as Alternative 1, and HCP funding for tributary improvements would potentially benefit vegetation by removing invasive non-native plant species, adding or enhancing soils, and establishing buffer areas along tributary streams

TABLE S-3. ENVIRONMENTAL COMPARISONS OF THE ALTERNATIVES (PAGE 6 OF 8)

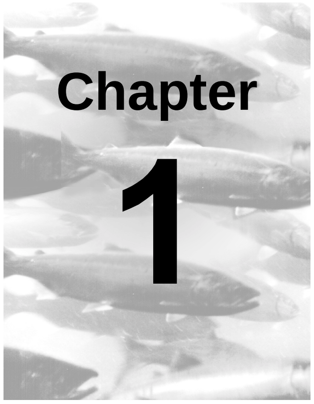
	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Columbia River System	No change from existing conditions	Same as Alternative 1	Same as Alternative 1
<u>Wildlife</u>			
Threatened and Endangered Species	**Dams:** No change from existing conditions	**Dams:** No effect anticipated. If drawdown occurs, bald eagle abundance may decline due to declines in waterfowl prey	**Dams:** Same as Alternative 2
	Tributaries: Possible short-term disturbance to bald eagles from tributary habitat improvement projects conducted by other agencies. Possible benefits to bald eagles if projects improve riparian habitat and waterfowl prey base	**Tributaries:** Same as Alternative 1	**Tributaries:** Same as Alternative 1. HCP funding for tributary improvements could enhance habitat
	No effects on northern spotted owls, gray wolves, or grizzly bears		
	No change from existing conditions		
	Columbia River System: No effect	**Columbia River System:** Same as Alternative 1	**Columbia River System:** Same as Alternative 1
Other Wildlife	**Dams:** Possible decline in gull abundance. No effect to other wildlife. No change from existing conditions	**Dams:** Same as Alternative 1. If drawdown occurs, declines in abundance of waterfowl, aquatic furbearers, amphibians, and other riparian-associated wildlife may result	**Dams:** Same as Alternative 2. In addition, HCP funding for tributary improvements could enhance habitat
	Tributaries: Possible short-term disturbance to wildlife from tributary habitat improvement projects conducted by other agencies. Possible benefits to waterfowl, aquatic furbearers, and other riparian associated wildlife, if projects improve riparian habitat	**Tributaries:** Same as Alternative 1	**Tributaries:** Same effects from PUD and other agency habitat improvement projects as Alternatives 1 and 2
	Columbia River System: No effect	**Columbia River System:** Same as Alternative 1	**Columbia River System:** Same as Alternative 1
<u>Land Use</u>			
Project Area	No changes from existing conditions	May be modified if listed species are affected	The PUD will consider land use when implementing measures under the HCPs

TABLE S-3. ENVIRONMENTAL COMPARISONS OF THE ALTERNATIVES (PAGE 7 OF 8)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Associated Tributaries	Local and State aquatic habitat enhancement projects may alter floodplains and result in land exchanges. Less development would be allowed at river shorelines. No change from existing conditions	Same as Alternative 1 unless the acquisition and conversion of existing land uses, such as agriculture commercial and residential to stream buffer habitat corridors, is necessary to prevent the extinction of listed species	Same as Alternative 2, although measures may result from actions taken for any of the plan species
Columbia River System	No change from existing conditions	Same as Alternative 1	Same as Alternative 1
<u>Economics</u>			
Project Area	No changes from existing conditions	Same as Alternative 1. If drawdown is proposed, a detailed economic analysis would be conducted	Same as Alternative 2
Tributary Habitat Improvement	Short-term local jobs in tributary habitat improvements. No change from existing conditions	Same as Alternative 1, If drawdown is proposed, a detailed economic analysis would be conducted	Same as Alternative 2 and Plan Species Account will provide some additional jobs and service related income
Columbia River System	No changes from existing conditions	Same as Alternative 1	Same as Alternative 1
<u>Recreation</u>			
Facility Operation and Maintenance	No changes from existing conditions	Same as Alternative 1. If drawdown occurs, reduced pool levels would make boat ramps and beaches unusable and substantially impact recreational facilities	Same as Alternative 2
Tributary Habitat Improvement	Short-term access may be affected as local and State aquatic habitat improvements occur. No change from existing conditions	Short-term access may be affected if tributary habitats were implemented to prevent the extinction of endangered species	Same as Alternative 2, although for all plan species. Same effects from PUD and other agency habitat improvement projects as Alternatives 1 and 2

TABLE S-3. ENVIRONMENTAL COMPARISONS OF THE ALTERNATIVES (PAGE 8 OF 8)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Columbia River System	No changes from existing conditions	Same as Alternative 1. If drawdown occurs, increased fishing upstream and downstream of the projects may result	Same as Alternative 2
<u>Cultural Resources</u>			
Project Area	No change from existing conditions	Same as Alternative 1. If drawdown occurs, substantial impacts could occur to cultural resources	Same as Alternative 2
Tributaries	Tributary habitat improvements could affect some cultural resources unless surveys and mitigation (if needed) are conducted prior to earth moving activities. No change from existing conditions	Same as Alternative 1	Same as Alternative 1
Columbia River System	No change from existing conditions	No change would occur. If drawdown occurs, impacts could occur to cultural resources at downstream dams	Same as Alternative 2



Chapter 1

Purpose and Need for Action

Chapter

1 PURPOSE AND NEED FOR ACTION

Key Terms *

Adaptive management - The process of monitoring the implementation of conservation measures, then adjusting future conservation measures according to what was learned. Adaptive management can also include testing of alternative conservation measures, monitoring the results, and then choosing the most effective and efficient measures for long-term implementation.

Biological assessment - A legally mandated requirement under the Endangered Species Act of 1973, to assess the affects of a Federal action on a Federally listed threatened or endangered species. A biological assessment report is prepared by the project proponent and provides existing and projected conditions that affect a threatened or endangered species and the proposed mitigation measures that minimize or avoid impacts to these species.

Biological opinion - A legal opinion from the U.S. Fish and Wildlife Service or the National Marine Fisheries Service as to the effects of a Federal action on a Federally listed threatened or endangered species. This biological opinion is a report that reviews and considers the adequacy of the biological assessment that is initially prepared by the project proponent. The biological opinion includes conservation measures recommended by the agency to protect the listed species.

Endangered Species Act - The Endangered Species Act of 1973, 16 U.S.C. ss 1531 through 1543, as amended and its implementing regulations. Federal legislation which provides a means to ensure the continued existence of threatened or endangered species and the protection of critical habitat of such species.

Habitat Conservation Plan (HCP) - Under Section 10 (a)(2)(A) of the Endangered Species Act, a planning document that is a mandatory component of an incidental take permit application. The HCP process is intended provide a comprehensive, long-term management plan to protect and facilitate the recovery of threatened and endangered species, and to provide a framework for "creative partnerships" between the public and private sectors in endangered species conservation (H.R. Rep. No. 97-835, 97th Congress, Second Session).

Incidental take permit - A permit that exempts a permittee from the take prohibition of Section 9 of the Endangered Species Act provided that a "conservation plan" has been developed that specifies the likely take and steps that the applicant will use to mitigate and minimize the take. An incidental take permit is issued by the USFWS or NMFS under Section 10 of the Endangered Species Act for non-Federal applicants.

Incidental take statement - An incidental take statement is issued under Section 7 of the Endangered Species Act for projects that involve a Federal action. The statement identifies the extent of the take that would occur as a result of the action, as well as reasonable and prudent measures to minimize the take.

No Surprises Policy - A policy of NMFS and USFWS providing regulation assurances for an HCP incidental take permit holder that no additional land use restrictions or financial compensation would be required with respect to species covered by the permit, even if unforeseen circumstances arise after the permit is issued that indicate additional mitigation is needed to protect the species.

* *See Chapter 6 for a complete listing of all Key Terms.*

1.1 INTRODUCTION

The U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS) is evaluating the decision to authorize incidental take permits for 50-year anadromous fish agreements and habitat conservation plans (HCPs) with two Washington State public utility districts (PUDs). The HCPs were developed to protect five species of Columbia River steelhead and salmon, two of which are currently listed as endangered under the Endangered Species Act. The fish protection measures of the HCPs are also intended to satisfy the PUD's obligations under the Federal Power Act, Fish and Wildlife Coordination Act, Pacific Northwest Electric Power Planning and Conservation Act, and Title 77 Regulatory Code of Washington (RCW). The agreements would set a "no net impact" standard for salmon and steelhead protection at three hydropower projects operated by the Chelan and Douglas County PUDs, and provide the PUDs with some degree of certainty for the long-term operation of these projects. Plan coverage of the three species not listed as endangered should reduce the possibility that these species would be listed in the future.

The anadromous fish agreements and HCPs are the result of more than 6 years of cooperative planning. In addition to NMFS and the PUDs, participants in the HCP development process are the U.S. Fish and Wildlife Service (USFWS); Washington Department of Fish and Wildlife (WDFW); the Yakama, Colville, and Umatilla Tribes; American Rivers, Inc., and the major wholesale purchasers of the PUDs electricity. [Note: Not all of these parties concur with the issues and measures identified in the current version of the HCPs.]

The NMFS is the Federal agency responsible for protecting anadromous salmon and steelhead and is the lead agency for this National Environmental Policy Act (NEPA) draft environmental impact statement (EIS). The Federal Energy Regulatory Commission (FERC) is a cooperating agency for the purposes of developing this draft EIS and the PUDs will coordinate compliance with the State Environmental Policy Act (SEPA).

To implement the HCP agreements, NMFS would issue incidental take permits under Section 10 (a)(1)(B) of the Endangered Species Act of 1973. The PUD No. 1 of Douglas County is applying for a permit covering the Wells project, and the PUD No. 1 of Chelan County is applying for permits to cover the Rocky Reach and Rock Island projects. The permit applications are based upon the HCPs and their exhibits.

The incidental take permits would be for four Permit species:

1. Upper Columbia River spring-run chinook salmon (*Oncorhynchus tshawytscha*),

2. Upper Columbia River summer/fall chinook salmon (*O. tshawytscha*),

3. Okanogan River and Lake Wenatchee sockeye salmon (*O. nerka*), and

4. Upper Columbia River steelhead (*O. mykiss*).

Currently, upper Columbia River steelhead and spring-run chinook salmon are listed as endangered under the Endangered Species Act. Although summer/fall chinook and sockeye salmon have not been listed, the permits apply to them according to the June 17, 1999 Federal policy governing the use of HCPs for the conservation of candidate or potential candidate species. The "no surprises policy" associated with these agreements ensures the PUDs that no additional measures will be required by NMFS for the duration of the permits, for any of the permit species.

Coho salmon *(O. kisutch),* an extinct species in the Mid-Columbia region, is also included in the HCPs as a "Plan species." Recently, attempts have been made to re-introduce coho salmon into the area.

Coho salmon are not considered a Permit species because an extinct species is not subject to Endangered Species Act jurisdiction. Thus, there are four Permit species and five Plan species.

1.2 Project Applicants

The project proponents are the following:

- The Douglas County PUD, a Washington municipal corporation, is sponsoring the Wells Anadromous Fish Agreement and HCP.
- The Chelan County PUD, a Washington municipal corporation, is sponsoring the Rocky Reach and Rock Island Anadromous Fish Agreements and HCPs.

The Chelan and Douglas County PUDs will file applications requesting FERC to amend their existing licenses to include the HCPs. In addition, the PUDs will rely upon the HCPs to fulfil their obligations for salmon and steelhead under new license agreements. The HCPs will meet the Endangered Species Act requirements for the permit species through the 50-year HCP terms.

1.3 Purpose and Need

The purpose of the HCPs is to protect fish in the Mid-Columbia River while generating electricity. The HCPs are needed to:

- obtain Section 10 incidental take permits, which would allow the Chelan and Douglas County PUDs to comply with the Endangered Species Act as they maintain and operate their power projects;
- support a comprehensive strategy for protecting and recovering five Plan species of anadromous salmonids in the Mid-Columbia River, two of which are currently listed as endangered under the Endangered Species Act;
- allow the Chelan and Douglas County PUDs to plan their long range operations with a degree of certainty of being able to economically operate their projects and fulfill their long-term bonding and contractual sales obligations;
- help ensure stable power supplies and pricing for the utilities' customers; and
- provide a coordinated approach to fisheries issues for relicensing the three projects under the Federal Power Act.

The HCPs are intended to constitute a comprehensive and long-term adaptive management concept for Plan species (spring-run and summer/fall chinook, sockeye, and coho salmon, and steelhead) and their habitat as affected by the hydroelectric projects.

Pending support of the HCP agreements by a coalition of Columbia River fishery resource managers and other public and private interests, their approval could reduce the risk of protests, delays or litigation during FERC relicensing for each of the three projects. They would also treat the areas around the three projects as a single habitat area, avoiding fragmentation.

The HCPs also include a “no surprises” clause that provides the PUDs with a degree of certainty regarding the required mitigation and costs associated with the 50-year HCP implementation period (see Section 1.5.2.1). At the same time, there are specific performance standards, time lines and termination clauses, as well as the adaptive management approach (see Section 1.5.2.1) to ensure that the HCPs are adequately protecting the resources.

1.4 PROJECT LOCATION

The Wells, Rocky Reach, and Rock Island hydropower projects are part of an 11-dam system on the mainstem Columbia River within the continental United States. Their location, relative to the other projects in the region is shown in Figure 1-1. Most of the projects on the mainstem Columbia River are Federally operated, although local PUDs operate five of the projects in the Mid-Columbia River segment. In addition to the three projects operated by the Chelan and Douglas County PUDs, the Grant County PUD operates the Priest Rapids and Wanapum dams.

The Douglas County PUD operates the Wells project located at river mile 515.8 on the Columbia River, north of the City of Wenatchee. Wells began commercial operations on August 22, 1967, and is operated under a license issued by FERC, which expires in the year 2012.

Chelan County PUD operates the Rock Island and Rocky Reach hydroelectric projects. Rocky Reach is about 8 miles upstream from the City of Wenatchee, at river mile 474.5. The Federal Power Commission issued the original operating license for Rocky Reach on July 11, 1957. The license expires in 2006. Rock Island, which was the first project to span the Columbia River, is located about 13 miles downstream from the City of Wenatchee at river mile 453.4. Rock Island began operating in 1933, and its operating license expires in the year 2028.

The project boundaries include the forebay (from the dam to approximately 500 feet upstream), tailrace (from the dam to approximately 1,000 feet downstream), and reservoir associated with each dam. The Rock Island reservoir extends approximately 20 miles upstream of the dam to the Rocky Reach tailrace; the Rocky Reach reservoir extends approximately 41 miles upstream of the dam to the Wells tailrace; and the Wells reservoir extends approximately 30 miles upstream of the dam to the Chief Joseph Dam tailrace. Considering all components of the three projects, the entire project area extends from the tailrace of the Rock Island Dam upstream to the tailrace of Chief Joseph Dam. Project effects however, may continue downstream through the Hanford reach to the McNary Dam (inclusively defined as the action area).

All three of the hydroelectric projects discussed in this EIS are "run-of-the-river" facilities, which means that they have limited storage capacity compared to larger reservoir projects, such as Grand Coulee and Chief Joseph.

1.5 REGULATORY FRAMEWORK

The utilities are acting within a very complex regulatory framework, particularly at the Federal level. This EIS has been prepared by NMFS, which is responsible for protecting anadromous fish under the Endangered Species Act. The EIS is being made available to the public as required by NEPA, as amended (42 USC 4321 *et seq.*), NEPA regulations (40 CFR 1500-1508), other Federal laws and regulations, and NMFS policies and procedures for implementing NEPA.

1.5.1 APPLICANT'S REGULATORY FRAMEWORK FOR COMPLIANCE WITH ENVIRONMENTAL LAWS

The PUD hydroelectric projects are licensed by FERC according to the Federal Power Act. Their existing licenses include requirements and restrictions about how the projects are maintained and operated. The utilities are also required to comply with other State and Federal regulations for

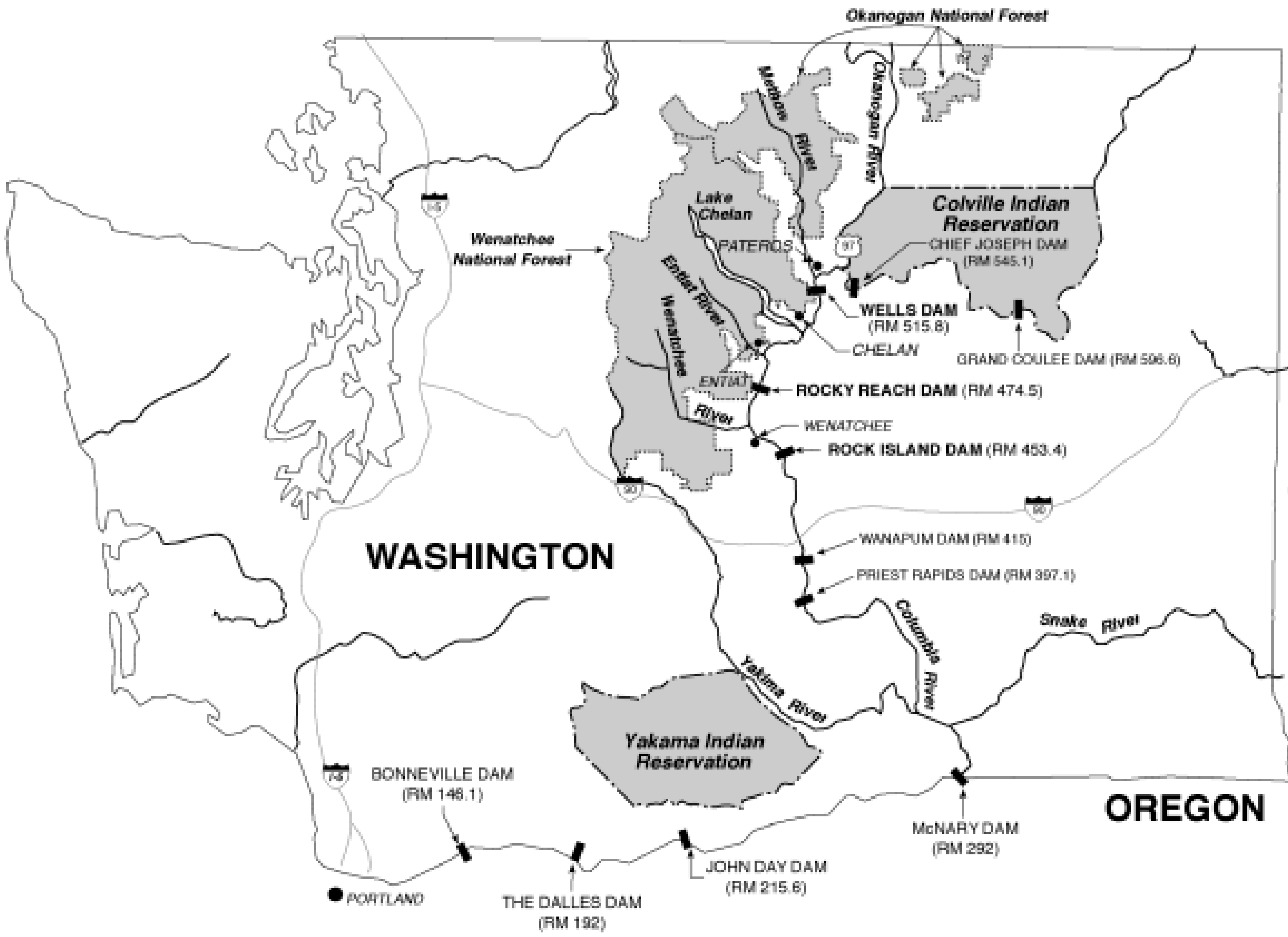


Figure 1-1
General Location of Columbia River Dams

environmental protection, and for planning and financing their long-range capital improvements.

1.5.2 Overview of Federal Requirements for Species Conservation

The Endangered Species Act of 1973 requires the protection and recovery of threatened and endangered species. The NMFS and the USFWS share joint authority under the Endangered Species Act for species protection. The USFWS is responsible for terrestrial and freshwater aquatic species, and NMFS is responsible for species in marine environments (mammals, anadromous fish, and other living marine resources). Anadromous salmon and steelhead spend the majority of their life cycle in the marine environment. Thus, NMFS is the responsible agency for their protection under the Endangered Species Act.

Section 9 of the Endangered Species Act prohibits the taking of an endangered species. Take is defined under the Endangered Species Act to mean "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect." Harm has been further defined by NMFS to include "significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, feeding, and sheltering." The NMFS (or USFWS) may issue permits, under limited circumstances, to allow the take of listed species incidental to otherwise lawful activities. These "incidental take permits" are issued for non-Federal actions under Section 10 (a)(1)(B) of the Endangered Species Act. Similarly, "incidental take statements" are issued for Federal actions under Section 7 (a)(2) of the Endangered Species Act. The NMFS implementing regulations governing threatened and endangered species are detailed in 50 CFR 222.307.

1.5.2.1 Endangered Species Act Requirements for Non-Federal Actions

Under Alternative 3, the PUDs (which are non-Federal applicants) would obtain incidental take permits under Section 10 (a)(1)(B) of the Endangered Species Act. To obtain the incidental take permit, a "conservation plan" (the HCP) must be provided to identify the likely impacts of the take and specify the mitigation and minimization steps the applicant will take. For a permit to be issued, Federal regulations specify that an HCP must meet several key criteria:

- The take will be incidental to an otherwise lawful activity.
- The applicant will, to the maximum extent practicable, minimize and mitigate the impact of such take.
- The applicant will ensure adequate funding for the plan.
- The take will not appreciably reduce the likelihood of survival and recovery of the species in the wild.
- The applicant will implement other necessary and appropriate measures to the plan, as determined by NMFS at the time of permitting.

If a conservation plan meets these criteria and is approved, the permits are valid for a specified term (50 years in these HCPs), as long as the applicant complies with the terms and conditions of the permit. No additional measures or conditions can be required.

The No Surprises Policy

Endangered Species Act regulations originally allowed NMFS and USFWS to add mitigation measures after a Section 10 permit is issued if "unforeseen circumstances" occurred, such as if the species continued to decline. This provided more flexibility to protect resources, but resulted in uncertainty for the permit holders. To address this uncertainty, the Clinton administration developed the "no surprises policy" in 1994, and the policy became a regulation in 1998 (50 CFR part 222). The no surprises policy means that, as long as an HCP is being properly implemented, the Section 10 permit is valid and nothing more can be required. Even if the species protected by an HCP unexpectedly worsens, the permit holder's costs for conservation and mitigation will remain as agreed. If additional measures are needed, the Federal government is responsible for implementing them.

Adaptive Management

The Wells, Rocky Reach, and Rock Island HCPs, like other recently developed HCPs, incorporate an adaptive management approach that helps provide a balance between the no surprises policy assurances and the risk that unknown factors might later jeopardize species recovery. An HCP must include measurable biological goals and objectives, negotiated during HCP development, that remain in place during the term of the HCP. The adaptive management approach allows the applicants, agencies and other parties to work cooperatively during HCP implementation and determine alternative strategies to meet the HCP goals when the initially adopted strategies do not successfully meet the objectives. An adaptive management approach would involve research and monitoring throughout the term of the HCP, and using what is learned to adjust conservation management actions.

Adaptive management is an essential element of HCPs that cover large areas or regions where a significant degree of biological uncertainty exists. When there are many unknown factors about a species in a plan area, the risk to the species increases, and a more intensive adaptive management approach is needed. The approach would involve more research and monitoring, with assessment milestones at frequent intervals. Details about the adaptive management approach are specified in the HCP implementation agreements and their exhibits. The Departments of the Interior and Commerce have recently drafted guidelines on adaptive management to make the approach a standard part of the HCP and Incidental Take Permitting Process (Federal Register 64 (45): March 9, 1999).

1.5.2.2 Endangered Species Act Requirements for Federal Actions

For Federal actions that may incidentally result in a take of listed species, a different process is used as defined under Section 7 of the Endangered Species Act. License-related actions by FERC would follow the Section 7 process, which involves "Federal consultations." Under the terms of Section 7 (b)(4) and Section 7 (a)(2), incidental takes that are not an intended part of the Federal agency's action can be allowed. Alternative 2 would involve the Section 7 process because FERC would continue to be responsible for directing Endangered Species Act compliance at the projects.

Whenever FERC is considering an action that may have an adverse effect on a listed species, it must consult with NMFS or the USFWS (FERC is currently involved in this process relative to the PUDs applications for approval of interim protection plans for the listed species). This action would cover the projects' operations until a decision is made on whether to approve the HCPs. The terms and conditions under the Section 7 process can be very similar to those under the Section 10 (non-Federal) process, with one key exception. Under Section 7, the Federal agencies must reinitiate their consultations if new information becomes available, and new terms and conditions can be required. FERC consultation responsibilities are broad under Endangered Species Act Section 7 (a)(1), but limited to proposed Federal actions (not licensee actions) in Section 7 (a)(2). FERC directs the licensee to comply with the Federal Power Act and Endangered Species Act requirements; implementation and compliance are up to the licensee.

1.5.2.3 NMFS Regulatory Requirements

The NMFS, as part of its responsibilities under the Endangered Species Act, is responsible for determining when a species is in jeopardy, regulating needed conservation efforts, and implementing species recovery plans. NMFS is also subject to the requirements of NEPA, and to a substantial number of other Federal regulations, policies, and orders.

Section 9 of the Endangered Species Act states that it is unlawful to take a listed species. However, if such taking is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity; the taking may be permitted through meeting other requirements of the Act, that may include Section 7 (Federal actions) or Section 10 (non-Federal actions). Section 4 of the Act is not applicable for endangered species, as occurs for the upper Columbia River steelhead and spring-run chinook .

With the listing of the endangered species in the Mid-Columbia River, NMFS is charged with helping to implement recovery plans that: (1) assess the factors affecting the species, (2) identify recovery goals, (3) identify actions needed to achieve the goals, and (4) estimate the cost and time to achieve the goals. Currently, NMFS policy is to allow these plans to be developed through cooperative efforts with local, regional and State governments, organizations, Tribes, and other parties. However, if a species continues to decline, NMFS has the authority to mandate recovery actions.

Through the development of this EIS, NMFS is fulfilling a key part of its regulatory requirements under NEPA for this proposed action. However, as the responsible agency for protecting salmon and steelhead under the Endangered Species Act, the agency has additional regulatory duties to perform before issuing an incidental take permit. After the EIS is complete, NMFS must prepare a biological opinion to determine if the operation of the Wells, Rocky Reach, and Rock Island projects in accordance with the HCPs, is likely to jeopardize the continued existence of Permit species in the action area.

The analysis that NMFS performs in developing the biological opinion can form the basis for defining reasonable and prudent measures needed to minimize the impacts of the incidental take. The measures become part of the terms and conditions of the incidental take permit or statement.

1.5.2.4 FERC Regulatory Requirements

The Federal Power Act provides FERC with the exclusive authority to license non-Federal waterpower projects on navigable waterways and Federal lands. Sections 4 (e) and 10 (a)(1) of the Federal Power Act provide guidance to FERC in licensing projects that allow a wide range of uses of the waterways. Sections 18 and 10 (j) of this Act also provide NMFS with strong and clear authorities for protecting fish. Consequently, the Federal Power Act provides a unique vehicle for achieving fishery management and species recovery goals.

For each project, FERC must decide (1) whether to issue the license to an applicant; and (2) the conditions that should be placed on the license to protect or enhance existing environmental resources; this includes mitigating for adverse environmental impacts that would occur due to the operation and maintenance of the project.

FERC determines whether a hydropower project should be developed; and if developed, under what conditions it should be operated. Before issuing a license, FERC must determine if a proposed project is “best adapted to a comprehensive plan for improving or developing a waterway or waterways” for beneficial public uses. The Commission must consider the project's consistency with Federal or State comprehensive plans for improving, developing, or conserving the waterway.

The Commission must weigh competing interests, including both power and non-power uses, to ensure a proper balance. The FERC licenses include engineering, safety, economic, and environmental requirements that must be met to keep the license in effect. For example, the license can include requirements for water quality monitoring, wildlife habitat creation, a public safety plan, and erosion control plans. As part of its licensing responsibilities, FERC must monitor the licensed projects to ensure compliance with regulations and terms and conditions with the license, including compliance with the Endangered Species Act and the Clean Water Act.

Recently, FERC has established an alternative administrative process to allow applicants to modify the timing of some steps of the licensing process (18 CFR, Parts 4 and 375; FERC, Order No. 5961 [Final Rule], October 29,1999). The primary change involves pre-filing consultations and environmental review, which can now be combined, and are designed to improve communication and coordination between the applicant, various Federal agencies, and other parties. The alternative process also allows for the NEPA process to begin the pre-filing stage for license applicants. Under this alternate process, the licensee would ask the Commission to incorporate the HCPs as license articles into the new license.

FERC does not operate projects licensed under the Federal Power Act but is responsible for requiring that the licensees comply with the Federal Power Act and related laws, including the Endangered Species Act. Proceedings to reopen existing licenses are subject to notice and hearing, other Federal Power Act protections, and the limitations of Federal Power Act, Section 6. The Commission's consultation responsibilities under the Endangered Species Act are described in Sections 7 (a)(1) and (2).

The incidental take permits issued by NMFS for the three projects will allow the PUDs to operate the projects following fish protection measures described in the HCPs. These measures will supercede any settlement agreements pertaining to Plan. If approved by FERC, the HCPs will be added to the existing licenses by amendment and will be included in any new license issued during the 50-year term of the HCPs.

The HCPs would be conclusively considered to fulfill the PUDs obligation to adequately and equitably conserve, protect, and mitigate the Plan species pursuant to the Endangered Species Act, Federal Power Act, and the Pacific Northwest Electric Power Planning and Conservation Act as those Plan species are affected by the projects through the term of the HCPs. WDFW will not request additional protection or mitigation for Plan species under Title 77 RCW. Any material modification of the HCPs terms, approval of less than the entire plan, or addition of material terms by any party of the agreement shall make the HCPs voidable at the option of any party.

Performance of the PUDs obligations under the HCPs is contingent on obtaining all necessary regulatory approvals, including applicable Federal, State, and local permits.

1.5.2.5 Other Federal, State and Local Requirements

Federal Power Act

This act provides for Federal regulation and development of waterpower and resources, authorizing the FERC to issue licenses for hydroelectric project works. The act also authorizes FERC to regulate the transmission and sale of electric energy in interstate commerce. This act requires that FERC licenses contain certain conditions. Projects must be adapted to a comprehensive plan for: (1) improving or developing a waterway for the use or benefit of interstate or foreign commerce; (2) improving and using water-power development; (3) adequately protecting, mitigating and enhancing fish and wildlife, including related spawning grounds and habitat; and (4) providing beneficial public uses, including irrigation, flood control, water supply and recreational purposes. Licenses also must contain conditions that adequately and equitably protect, mitigate damages to, and enhance fish and wildlife affected by project development, operation and management.

Fish and Wildlife Coordination Act

Whenever the waters or channel of a stream or other body of water are proposed or authorized to be modified by a public or private agency under Federal permit or license, the agency first shall consult with the USFWS and with NMFS where the impoundment, diversion or other control facility is to be constructed, with a view to conserving fish and wildlife. The Act's purposes are to recognize the contribution of our fish and wildlife resources to the nation, and their increasing public interest and significance, and to provide that fish and wildlife conservation receives equal consideration and be coordinated with other features of water-resource development programs through planning, development, maintenance and coordination of fish and wildlife conservation and rehabilitation.

Pacific Northwest Coordination Agreement

This Agreement was originally executed in 1964, and was revised in 1997 extending the Agreement until 2024. The Agreement is an important component of regional plans to maximize the Northwest's hydro resource capability. Maximization also included the development of three storage projects on the Columbia River in Canada pursuant to the terms of the 1964 Columbia River Treaty between Canada and the United States (Treaty). These storage dams provide regulated streamflows that enable Federal and non-Federal hydroelectric projects downstream in the United States to produce additional power benefits. The Treaty requires the United States to deliver to Canada one-half of these downstream power benefits (known as the Canadian Entitlement). The non-Federal utilities of the region committed to provide a portion of the share of Treaty benefits required to be delivered to Canada. In return, the United States Government agreed to participate in the coordinated operation. The Federal and non-Federal allocation was the subject of a separate ROD; the Canadian Entitlement Allocation Extension Agreement (CEAEA) ROD was issued on April 29, 1997 by BPA.

Northwest Power Act

The Northwest Power Act, formally "Pacific Northwest Electric Power Planning and Conservation Act" was formed to address regional environmental and power production coordination and management issues in the Columbia basin. The Mid-Columbia utilities are subject to the Act, although most of the requirements for its projects are implemented through the licensing processes managed by FERC. The major provisions of the Northwest Power Act are to:

(1) Form the Northwest Power Planning Council to help the region develop a strategy to meet its electrical needs at the lowest possible cost.

(2) Make the Bonneville Power Administration (BPA) responsible for system operational planning, and for managing the regional electrical system to achieve goals for fish protection and system efficiency.

(3) Protect and enhance existing Federal laws that provide supply preference and price advantages to co-ops and publicly owned utilities.

(4) Establish a program (through the Northwest Power Planning Council) to protect and enhance the fisheries resources of the Columbia River and to mitigate damage already done to anadromous fish populations, with funding from BPA rate revenue.

(5) Involve the public in planning for electric resources and fish protection. State and local agencies are to retain control of land use and water rights.

(6) Instruct the Northwest Power Planning Council to provide a method for balancing

environmental protection and the energy needs of the region.

(7) Require the Northwest Power Planning Council to seek the recommendations of the region's tribal, State and Federal fish and wildlife agencies, and ensure that its measures are consistent with the legal rights of the region's Tribes.

Clean Water Act: 401 Water Quality Certification

Under Section 401 (a)(1) of the Clean Water Act, project applicants must have a State certification to verify that their project discharges comply with the applicable provisions of the Clean Water Act, or the applicant must have a waiver of certification from the State. In Washington, the WDOE is responsible for water quality permitting issues. FERC also requires licensing applicants to apply for water quality certifications or waivers before they file their FERC license application.

Magnuson-Stevens Fishery Conservation and Management Act

In 1996, the Magnuson-Stevens Act was re-authorized and changed by amendments to emphasize the sustainability of the nation's fisheries and establish a new standard by requiring that fisheries be managed at maximum sustainable levels and that new approaches be taken in habitat conservation. These approaches include identifying essential fish habitat that includes those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. The Magnuson-Stevens Act is a national program developed for the conservation and management of the fishery resources of the United States to prevent over fishing, to rebuild over fished stocks, to ensure conservation, to facilitate long-term protection of essential fish habitats, and to realize the full potential of the Nation's fishery resources.

Title 77 Revised Code of Washington

This State code recognizes that wildlife is the property of the State, which has the obligation of preserving, protecting, and perpetuating wildlife. Conservation, enhancement, and proper utilization of the State's natural resources, including lands, waters, timber, fish and game are the responsibilities of the State. While fully respecting private property rights, all resources in the State's domain shall be managed by the State such that conservation, enhancement and proper utilization are primary considerations.

State Environmental Policy Act

The SEPA provides a process for analyzing the environmental impact of proposed developments or actions. The responsible agency for approving or implementing a project must disclose its likely adverse environmental impacts, and must identify mitigation measures to minimize or mitigate significant adverse impacts. A variety of documentation approaches can be used to satisfy SEPA requirements, ranging from the preparation of a SEPA checklist to the development of an EIS.

For this project, the NEPA requirements and regulations will be designed to meet the SEPA requirements, which includes development and publication of an EIS. The PUDs are the lead State agencies for this EIS. Other applicable State agencies have been contacted through direct phone contact, meetings, and project mailings. These agencies and State representatives have provided input and comment during development of this EIS. The PUDs currently intend to use the Federal EIS to satisfy SEPA requirements.

Hydraulic Code

The State Hydraulic Code is intended to protect State aquatic resources from damage by construction and other activities. It applies to construction in all marine and fresh waters in the State. The code is implemented through a permit called the Hydraulic Project Approval obtained from WDFW for all construction activities within the high water areas of State waters. Some of the activities involved in the alternatives would require this approval.

Local Government Codes and Policies

A variety of local government codes and policies would apply to the programs or activities included in the alternatives. The requirements of all applicable local codes would be identified prior to implementing any new activities, and all necessary permits and approvals would be obtained to ensure that the project developments are in compliance with local laws.

1.5.2.6 Federal Trust Responsibilities to Indian Tribes

Three Tribes (the Confederated Tribes of the Colville Indian Reservation, the Confederated Tribes and Bands of the Yakama Indian Nation, the Confederated Tribes and Bands of the Umatilla Reservation) and the Columbia River Inter-Tribal Fish Commission have been active participants and commenters in the development of the three HCPs. The Federal government has a trust and legal responsibility to Native American Indian Tribes, which comes from commitments made by the United States in treaties, executive orders, and agreements. Upholding these tribal rights specified in the commitments constitutes the Federal government's legal responsibility. The Federal government also has a responsibility to consult with affected Tribes whenever its actions affect the resources upon which tribal hunting, fishing, gathering, and grazing rights depend. Tribal consultation will occur under any of the alternatives selected.

The rights reserved by the Tribes in treaties and agreements, or which were not expressly terminated by the Congress, continue to this day. These governmental rights and authorities extend to any natural resources, which are reserved by or protected in treaties, Executive Orders and Federal statutes. The courts have developed the Canons of Construction, guiding premises, that treaties and other Federal actions "should, when possible, be read as protection of Indian rights in a manner favorable to Indians" (Cohen 1986).

Several issues raised by the Tribes during the HCP negotiating process and during the initial scoping effort for this EIS, have been difficult to adequately reconcile. For example, in an effort to preserve stock structure within the listed populations, NMFS has indicated that disproportionately high levels of naturally spawning hatchery fish may affect the continued existence of Endangered Species Act listed species (due primarily to the intermixing of genetic code). As a result, NMFS has been reluctant to guarantee the 7 percent supplementation levels negotiated in the HCP. Without this guarantee, the supplementation levels critical to the Tribes, and a key component of their support for this agreement, may be modified (i.e., reduced). Without a guarantee from NMFS that the 7 percent compensation levels would be attained under all circumstances, the Tribes may not endorse the HCPs.

1.5.3 LISTINGS WITH MAJOR IMPACTS ON APPLICANTS MANAGEMENT AREAS

The NMFS listed upper Columbia River steelhead and spring-run chinook salmon as endangered under the Endangered Species Act in 1997 and 1999, respectively. Critical habitat for these species has been determined to include major Columbia River tributaries known to support these evolutionarily significant units (NMFS 2000a). For the upper Columbia River spring-run chinook evolutionarily significant unit, these include the Wenatchee, Entiat, Methow river basins, as well as the Columbia River and estuary. In addition to these same areas, critical habitat for upper Columbia River steelhead includes the Okanogan River.

The USFWS also listed Columbia River bull trout as threatened in 1999. Due to comments on the proposed listing and unresolved issues, the Service did not make a final rule on critical habitat designations at the time of the listing. In addition, USFWS also has not yet made Endangered Species Act Section 4 (d) recommendations for the threatened species within the HCPs management areas. The designation of critical habitat and the 4 (d) recommendations are expected within 1 year.

The Endangered Species Act listings have impacts on the applicants' management areas. The PUDs began to develop the HCPs in the early 1990s as they recognized the likelihood of the listings and the probable effects it would have on their operations. Over the course of several decades, the PUDs have made physical and operational changes to their hydropower projects to minimize their effects on salmon and steelhead species.

Other projects in the Columbia River system have been taking similar steps, and the ongoing operations of the overall system is being coordinated to help provide the most conducive conditions for salmon and steelhead migrations. Hydropower operations throughout the Columbia River basin have been found to be one reason for the decline of Columbia River salmon and steelhead species. Hydropower development has impacted these species through the loss of habitat above the projects (particularly with the large reservoir projects such as Grand Coulee where fish passage is currently impossible), and it has increased the degree of mortality during migration (NMFS 1996). There is currently only limited data concerning potential impacts of hydropower development to bull trout populations. The effect of Wells, Rocky Reach, and Rock Island on bull trout is not known.

1.6 PROPOSED ALTERNATIVES

One no-action alternative and two action alternatives were developed for this EIS analysis. The no-action alternative addresses baseline conditions that are represented by the FERC-issued operating licenses for the three projects, as well as amendments to the licenses including Settlement Agreements that pertain to anadromous fish. The action alternatives address Endangered Species Act requirements.

1.6.1 ALTERNATIVE 1 (NO ACTION)

Alternative 1 (no action) is required by Council of Environmental Quality regulations (40 Code of Federal Regulations [CFR] 1502.14[d]), and is intended to provide baseline information for understanding the effects of the proposed action alternatives, including existing and future conditions.

Each of the three hydroelectric projects operate under FERC-issued operating licenses including: (1) the 1953 Rocky Reach license, (2) the 1962 Wells license, and (3) the 1989 Rock Island license. Amendments to the licenses have been added over the years to address engineering, bond, and resource related issues (i.e., anadromous fish issues).

Existing anadromous fish protection agreements for the Wells, Rocky Reach, and Rock Island projects are documented in the 1990 Wells long-term Settlement Agreement (FERC 1991), the Fourth Revised Rocky Reach Interim Stipulation (expired) (FERC 1996b), the Rock Island Settlement Agreement (FERC 1989b), and the Vernita Bar Agreement (FERC 1988). Complete discussions of the ongoing actions at each project are included in Section 2.2.

The licenses and amendments apply primarily to the immediate vicinity of the dams, although mitigation areas may include wildlife habitat and recreational enhancements outside the immediate project area. Hatchery and supplementation measures associated with the projects are also located throughout the Mid-Columbia River basin. In addition to mitigation for continuing operations, the original licenses include measures intended to compensate for the loss of wild fish that resulted from the initial construction of the projects.

Actions applicable to anadromous salmon and steelhead that are currently being implemented under existing FERC license articles and settlement agreements generally fall into three categories: (1) measures to improve juvenile survival, (2) measures to improve adult survival, and (3) measures to mitigate for the unavoidable project mortalities of anadromous fish. Although similar actions to address the effects of project operations on anadromous salmon and steelhead exist at each of the three projects being considered in this EIS (i.e., development of juvenile bypass facilities, implementation of supplemental spill programs, operation and maintenance of adult fishways, hatchery compensation measures, etc.), many of the details are unique to each dam.

With the listing of spring-run chinook salmon and steelhead under the Endangered Species Act, came an additional requirement to reevaluate the effects of project operations and ongoing mitigation efforts on listed species, and to potentially implement additional measures to ensure that these species continue to exist into the future. Alternative 1 does not address these requirements. Both of the action alternatives, however, do address these requirements and will provide FERC and the PUDs legal coverage from the take prohibitions under Section 9 of the act. Alternative 2 represents the process that FERC must follow to obtain this coverage (Section 7) and Alternative 3 represents a process that each of the PUDs could utilize to consult directly with NMFS (Section 10). Although either process would satisfactorily address requirements of the Endangered Species Act for both FERC and the PUDs, there are significant procedural differences.

1.6.2 ALTERNATIVE 2

To obtain legal coverage from the take prohibitions addressed under Section 9 of the Endangered Species Act, FERC and the PUDs would participate in Section 7 consultations (Alternative 2). These consultations would determine the effects of project operations on listed species, would determine the measures necessary to prevent the extinction of listed species (while allowing adequate potential for recovery), and would determine the measures necessary to prevent the destruction or adverse modification of critical habitat (up to full mitigation for the project effects).

Due to their status under the Endangered Species Act, Alternative 2 would only apply to endangered Upper Columbia River spring-run chinook salmon and steelhead (and possibly to Mid-Columbia River steelhead, listed as threatened, if NMFS determines that continuing operations may affect this species).

Measures required as a result of these consultations would only be implemented following extensive negotiations between NMFS, FERC, and the PUDs. At this time, neither FERC nor the PUDs have agreed to the full range of measures developed by NMFS for Alternative 2. These measures were developed based on site specific information to the extent possible, and on operational and structural measures implemented at other mainstem Columbia and Snake River hydroelectric projects, with similar configurations. Both the impacts of these likely measures on listed species and the effects of these measures on other natural resources in the action area have been evaluated in this EIS.

In addition to required research and monitoring efforts, the following measures, or combination of measures, could potentially be required as a result of Section 7 consultations:

1. The development, construction, and operation of juvenile fish bypass systems at each of the three projects, including both surface and guidance screen bypass systems to maximize passage over the dams through non-turbine routes.

2. Increasing spill volumes to facilitate the downstream migration and survival of juvenile salmon and steelhead.

3. Physical and operational turbine unit modifications to improve the survival of fish passing the project via the powerhouse.

4. Modifications to the adult ladders as necessary to reduce passage times, and/or the construction of additional adult passage facilities to further facilitate upstream passage and spawning success.

5. Increased operation of juvenile bypass facilities and additional spill to promote the downstream passage of adult migrants (particularly post-spawning adult steelhead [kelts]).

6. Modification of power peaking operations to reduce the potential direct and indirect affects on Endangered Species Act-listed salmon and steelhead.

7. Improvements in tributary habitat if the project specific measures have not adequately addressed the effects of project operations.

8. Other non-power actions (i.e., drawdown) if the combination of project and habitat related measures has not adequately addressed the decline of listed species.

Neither FERC nor the PUDs have agreed to these measures and the actual implementation schedule may be delayed due to the required Endangered Species Act consultations. During these consultations, only the measures described in the existing FERC license articles and settlement agreements would be implemented. Although consultations are not expected to exceed several months, if agreement cannot be reached on the measures to be implemented additional actions could be delayed indefinitely.

1.6.3 ALTERNATIVE 3 (PROPOSED ACTION)

Alternative 3 is defined as continued operation of the Wells, Rocky Reach, and Rock Island hydroelectric projects as modified by the HCPs. If analysis of the HCPs determines that Endangered Species Act-listed species would survive into the future with adequate potential for recovery, and that there would be no detrimental effects to other natural resources within the action area, then NMFS would issue incidental take permits under Endangered Species Act Section 10 (a)(1)(B) to the Douglas and Chelan County PUDs. As a result, FERC would amend each of the respective PUD operating licenses to include all of the measures identified in the HCPs, for each of the Plan species. Unlike Alternative 2, FERC staff and the PUDs have already agreed to the measures identified in the HCPs. Therefore, there would be no delay in implementing measures once the incidental take permits are issued.

In order to satisfy Federal Power Act requirements, specifically NMFS statutory authorities under Sections 10 (j) and 18 of the Federal Power Act, other Federal and State resource agencies and Tribes, and interested non-governmental organizations, must also agree to implementation of the HCPs. To ensure that their issues are satisfactorily addressed, NMFS and the PUDs have been encouraging their participation throughout the HCP development process. Further, to ensure that each of these organizations has a continuing role in the implementation process, specific Coordinating Committees, comprised of a representative from each organizations that endorses the HCPs, would be established under Alternative 3. These Coordinating Committees would have specific roles as defined in the HCPs, generally governing implementation of all measures throughout the 50-year term of the agreements.

With the support of the Federal and State resource agencies and Tribes, and interested non-governmental organizations, the HCPs would supercede the existing FERC license articles and settlement agreements as they pertain to anadromous fish at the Wells, Rocky Reach, and Rock Island hydroelectric projects. The HCPs consist of a performance-based standards approach to govern the specific actions that would occur at each dam over the next 50 years. The no net impact standard consists of two primary components

1. Ninety-one percent project survival, achieved within the geographic area of the projects, by project improvement measures, including an

independent standard of 95 percent juvenile dam passage survival; and

2. Nine-percent compensation for unavoidable project mortality provided through hatchery and tributary programs, with 7 percent compensation provided through hatchery programs[1] and 2 percent compensation provided through tributary programs.

These actions are intended to contribute to the rebuilding of tributary habitat production capacity and basic productivity and numerical abundance of Plan species.

In order to meet the no net impact objectives the utilities would:

- evaluate project specific survival rates,
- implement hatchery production and tributary improvement projects and changes in how the hydropower projects are operated,
- conduct a variety of scientific and engineering studies and projects related to the design and operation of the hydropower projects, and
- establish a Plan Species Account that would receive annual funding from the PUDs over the lifetime of the HCPs to pay for the habitat improvements and studies.

If this performance-based standards approach satisfactorily addresses the needs of Endangered Species Act-listed anadromous fish, then NMFS would issue an incidental take permit for the full 50-year term of the HCPs. If the status of the currently unlisted Plan species deteriorates in the future, to the point where listing under the Endangered Species Act is required, no additional actions would be required at the Wells, Rocky Reach, and Rock Island projects if the HCPs are being implemented as negotiated. (Section 7 consultations for the anadromous fish currently listed under the Endangered Species Act would begin following the public comment period on this EIS. This allows the HCPs to be updated with information received during the comment period, and allows NMFS to consult over the final proposed HCPs.)

The PUDs may elect to utilize any or all of the measures identified in Section 1.6.2 if necessary to meet the no net impact standard for each of the Plan species. All activities to implement the HCPs and fulfill FERC requirements would be covered by the incidental take permits. The PUDs would receive incidental take permits for Permit species when the HCPs become effective. If the PUDs carry out the fish protection and mitigation measures consistent with the survival standards set forth in the HCPs, and provide the necessary monitoring and evaluation according to the time frames set out in the HCPs, the incidental take permits shall continue for the full 50-year HCP term.

Because the PUDs have already agreed to this performance-based standards approach, there would be no delay in implementing any actions necessary to meet the no net impact standard for all Plan species. The PUDs have been operating under the guidelines of the HCPs since 1998, when the proposals were originally submitted to NMFS as applications for incidental take permits. Over the last two years, several evaluations were conducted to determine the current survival levels at each project and to determine the appropriate actions necessary to improve survival where necessary. By 2003, Chelan County PUD would begin to assess the survival of the Plan species to ensure that modifications made since 1998 have satisfactorily achieved the HCP standards. Douglas County PUD is currently conducting survival evaluations to verify that the 95 percent juvenile passage survival standard has been met.

[1] Depending on the actual number of hatchery fish required to meet the 7 percent commitment, NMFS may conclude at a future date that the genetic integrity of wild fish would be compromised by the potential for hatchery and wild fish to interbreed. If this occurs, the PUDs (although committed to the 7 percent production level) would not be permitted by NMFS to meet this standard. The NMFS decision to reduce the number of hatchery fish produced by the PUDs does not affect their commitment to or the implementation of the HCPs.

1.7 BACKGROUND

The development of the Columbia River hydroelectric system began in the 1930s. Over a period of nearly 40 years, thirty multi-purpose projects on the Columbia River and its tributaries were built by the U.S. Army Corps of Engineers and the Bureau of Reclamation (BOR). Investor-owned and publicly-owned utilities also built a major system of projects and generating facilities. The projects were designed to meet regional needs of electric power production, land reclamation, flood control, navigation, recreation and other river uses. During that time, the BPA also built and began to operate transmission lines to deliver the power from projects, and to market electricity from Federal projects.

As demand for power grew, the United States and Canadian governments negotiated a treaty in the early 1960s for the cooperative use of water storage projects that would be built by both countries in the upper reaches of the Columbia (see Section 1.6.2.5). Four treaty projects were built, with three on the Columbia River in Canada and a fourth on a major Columbia tributary in Montana. These projects, which were developed in the early 1970s, provide flood control and additional power generation at projects downstream in the United States. The power-generating capability of downstream projects was increased as a result of the treaty storage, including an 18 percent increase at five Mid-Columbia PUD projects.

Over the past several decades, populations of salmon and steelhead throughout the west coast have declined. Since 1991, NMFS has listed over 20 species of salmon and steelhead as threatened or endangered. This decline has been particularly notable in the Columbia River system, which includes the Snake River. A century ago, between 10 million and 16 million salmon returned to the Columbia each year. By the late 1970s there were only about 2.5 million salmon, and most of those were of hatchery origin. The NMFS listings noted that the declines were due to many factors, including hydroelectric and irrigation projects; commercial and sport fishing; logging; mining; livestock grazing; water use by farms, cities and towns; and municipal and industrial pollution. In addition, natural events (such as flooding, landslides, drought and ocean conditions) had inflicted a toll on fish.

Although dam removal has been suggested as an option for some projects, there remains an acute need for power production in the Pacific Northwest. According to industry information, the Pacific Northwest does not presently have adequate power production resources to meet its load requirements. By the early 2000s, the Pacific Northwest is projected to have an energy deficit of 24 million megawatt hours, and the deficit will rise to 25 million megawatt hours by 2003 (Pacific Northwest Utility Conference Committee, "Northwest Regional Forecast of Power Loads and Resources" March 1988). A recent study for the Northwest Power Planning Council also found that there is an increasing likelihood that peak power demand will outstrip supply in some areas, particularly during the winter months. As this occurs, there is a greater potential for disruptions to power users (Northwest Power Planning Council, November 1999).

Each of the three hydropower projects on the Mid-Columbia River has a unique development history, but all projects were developed primarily to serve customers in nearby areas. The physical and operational features of each project reflect its location on the river and the engineering and scientific information that was available at the time the projects were developed. Specific facilities and operations of each of the projects are described in Section 2.2.

1.7.1 PLAN AREA

The plan area is located on the middle reach of the Columbia River, at the geographic center of Washington State. The Columbia River system is the second largest in North America. The river and its tributaries drain an area of 260,000 square miles in seven western States and 39,650 square miles in British Columbia. In the United States, most of the basin is in Washington, Oregon, Idaho and Montana. The river originates at Columbia Lake in the Rocky mountain range of British Columbia, and travels over 1,200 miles to the Pacific Ocean through Washington and Oregon.

The Mid-Columbia River reach is defined as the area of the river between the Chief Joseph project and the confluence of the Yakima River. It contains the three projects covered by this EIS (Wells, Rocky Reach, and Rock Island), as well as two dams (Priest Rapids and Wanapum) operated by Grant County PUD. It also includes the free-flowing Hanford reach downstream of the Priest Rapids project. The major tributaries to the Mid-Columbia River are the Okanogan, Methow, Entiat and Wenatchee rivers. Note that NMFS listings refer to species in this reach as “upper Columbia River” species.

The three hydropower projects operate on the mainstem of the Mid-Columbia River (Figure 1-2), with the Wells project at river mile 515.8, the Rocky Reach project at river mile 474.5, and the Rock Island project at river mile 453.4. The geographic scope for the analysis has been defined by the physical limits or boundaries of the project's likely direct effects on the resources. It also considers the extent of the contributing effects of other hydropower activities within the Columbia River basin. The geographic project scope is separated into three tiers associated with direct facility improvements (at the projects), habitat and hatchery improvements (in the Wenatchee, Entiat, Methow, and Okanogan rivers), and cumulative effects (including the other projects on the Columbia River).

The first tier represents the project area described in Section 1.4 and extends from the tailrace of the Rock Island Dam to the tailrace of the Chief Joseph Dam. The second tier represents the four tributaries associated with a Tributary Conservation Plan to address improvements to the Wenatchee, Entiat, Methow, and Okanogan rivers (Figures 1-3 to 1-6). The third tier is associated with *cumulative effects* of the HCPs with other ongoing and proposed fish protection measures being implemented at other projects in the Columbia River. This tier includes the entire Columbia River from the mouth upstream to Chief Joseph Dam where fish movement through this dam is blocked (Figure 1-1).

The cumulative effects analysis for anadromous fish is a separate assessment conducted by NMFS and funded by the PUDs, the BPA, the Army Corps of Engineers, and the BOR. This assessment is known as the Quantitative Analytical Report (QAR), and is a comprehensive analysis of the proposed protection measures within the Columbia River on the biological requirements of the listed species. The report assesses the likelihood that the combined effects of the proposed long-term measures at the PUD and Federal projects, and the proposed hatchery production levels, and habitat enhancement measures will lead to the survival and recovery of the listed species. The findings of the QAR are presented in this EIS under cumulative effects for fish.

Land use throughout this area varies, but it is primarily rural with the exception of the urbanized areas of Wenatchee and East Wenatchee. The other areas include rangeland, irrigated farmlands, and a mixture of private and Federally owned lands. Sections of the Okanogan and Wenatchee National forests and some Bureau of Land Management (BLM) lands are also found in the drainages within the Plan areas.

The Mid-Columbia River area is served by a regional transportation system consisting primarily of Federal and State highways. On the eastern shoreline of the river from the Wells project going south there are no roads until U.S. Highway 97 crosses the river at Chelan Falls. Further south at Orondo, U.S. Highway 2 joins with U.S. Highway 97. North of Wenatchee, U.S. Highway 2 and 97 cross the river heading west, while State Route 28 is initiated and continues on the eastern Columbia River shoreline south past the Rock Island project. On the western side of the river in the vicinity of the Wells project are U.S. Highway 97 and

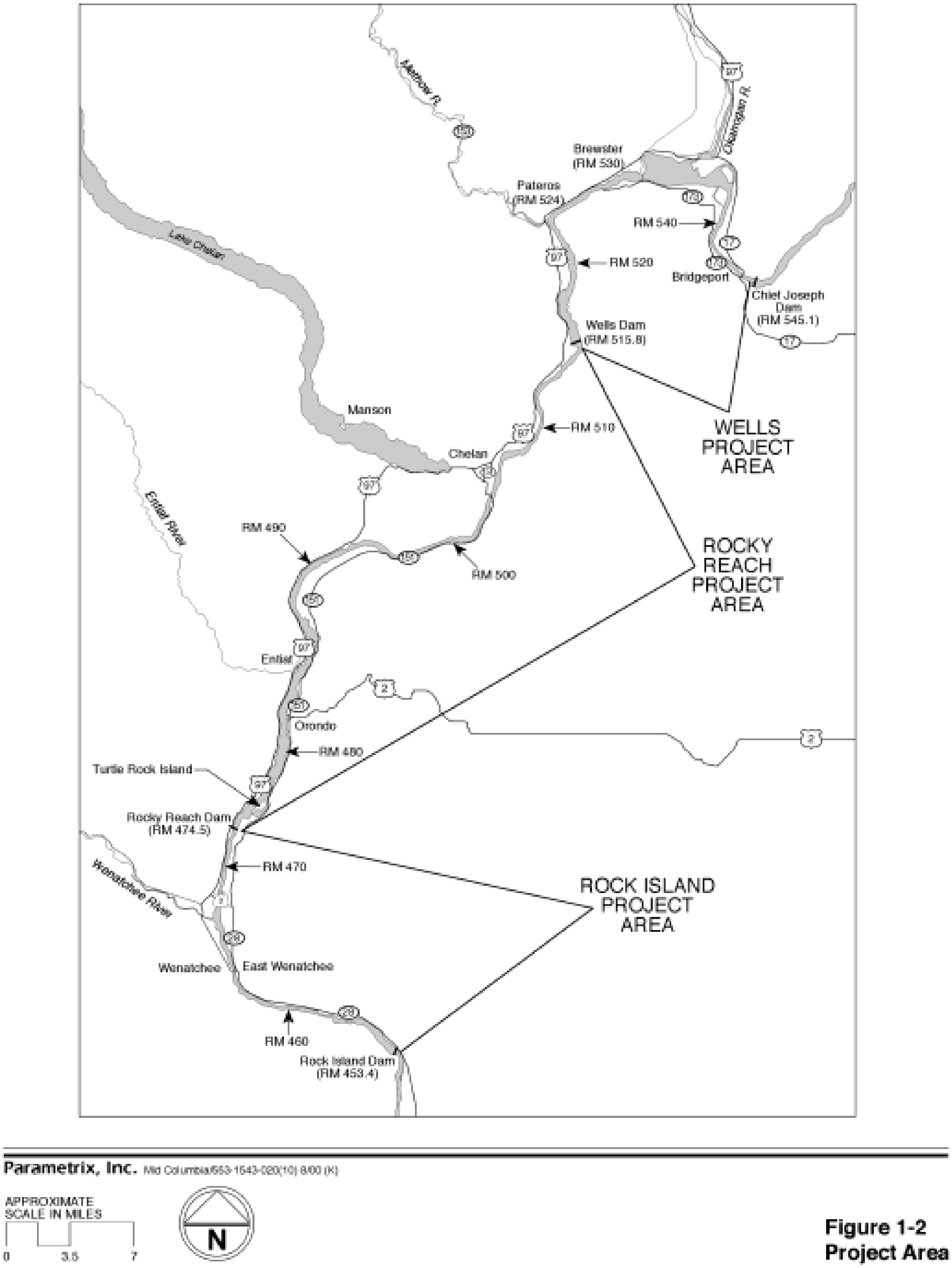
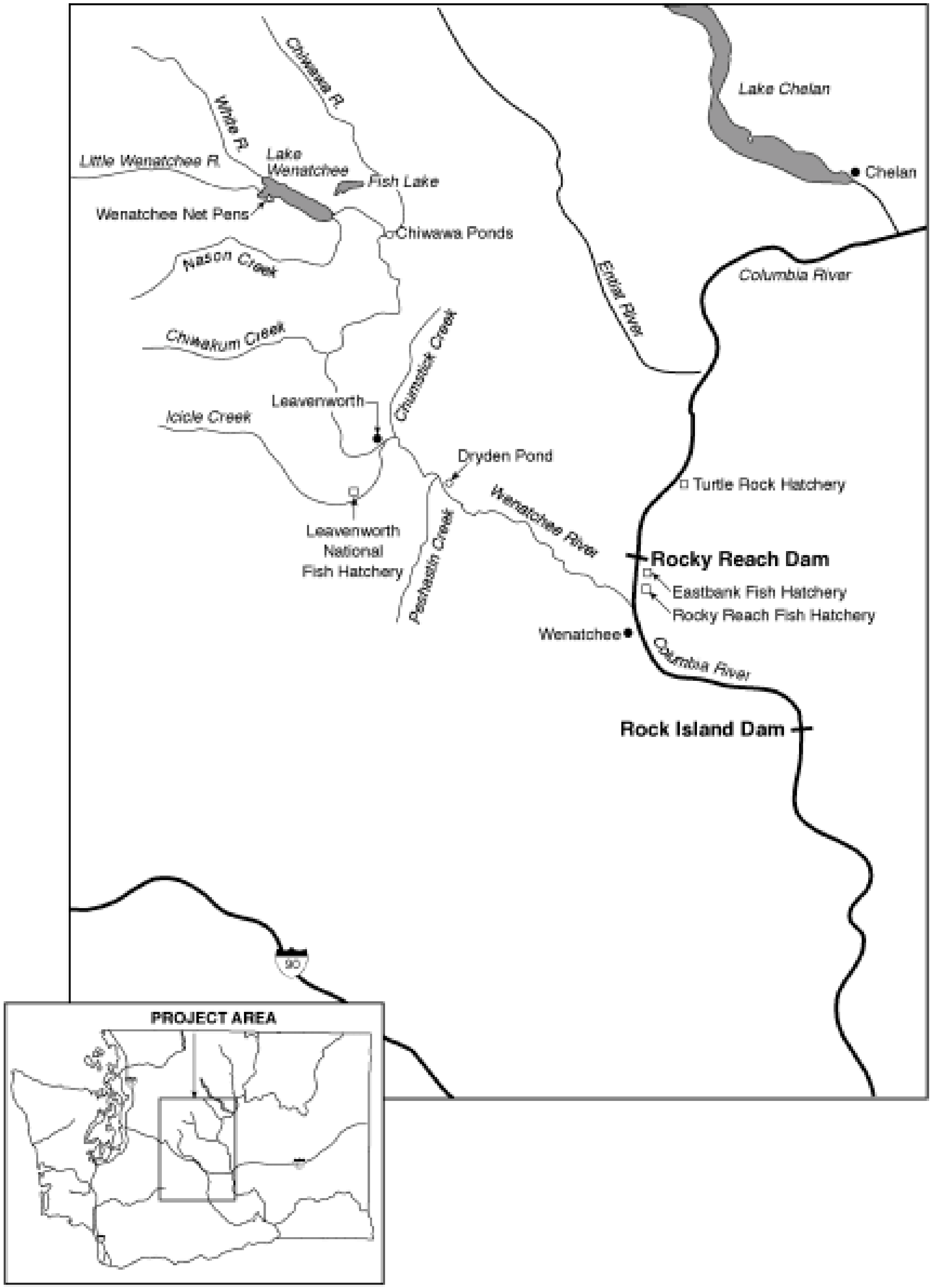


Figure 1-2
Project Area

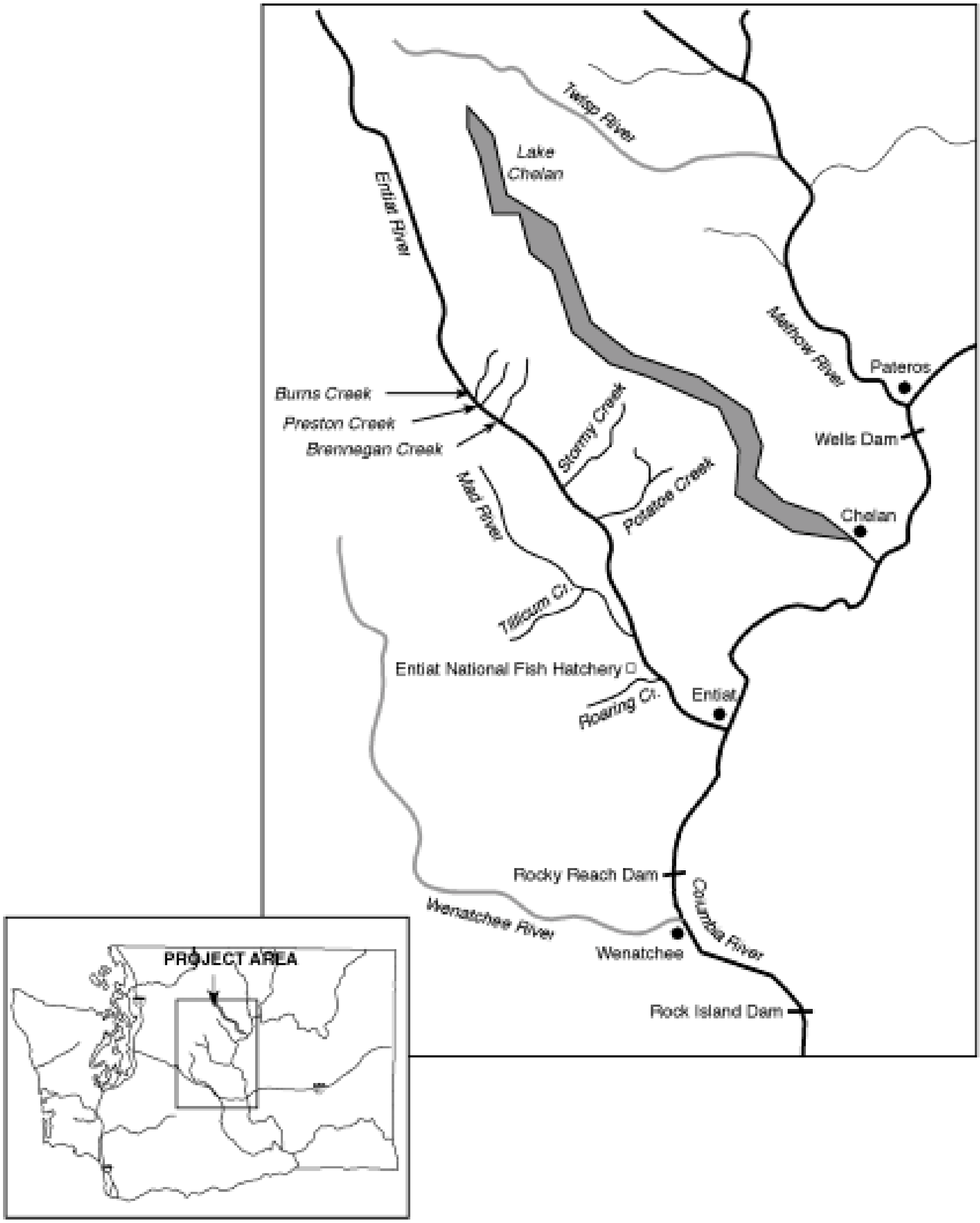


Parametrix, Inc. Mid-Columbia EIS/553-1543-020(10) 6/00 (K)

N
NOT TO SCALE

Dam
City
Hatchery
Pond

Figure 1-3
Wenatchee River and Associated Creeks and Fish Facilities



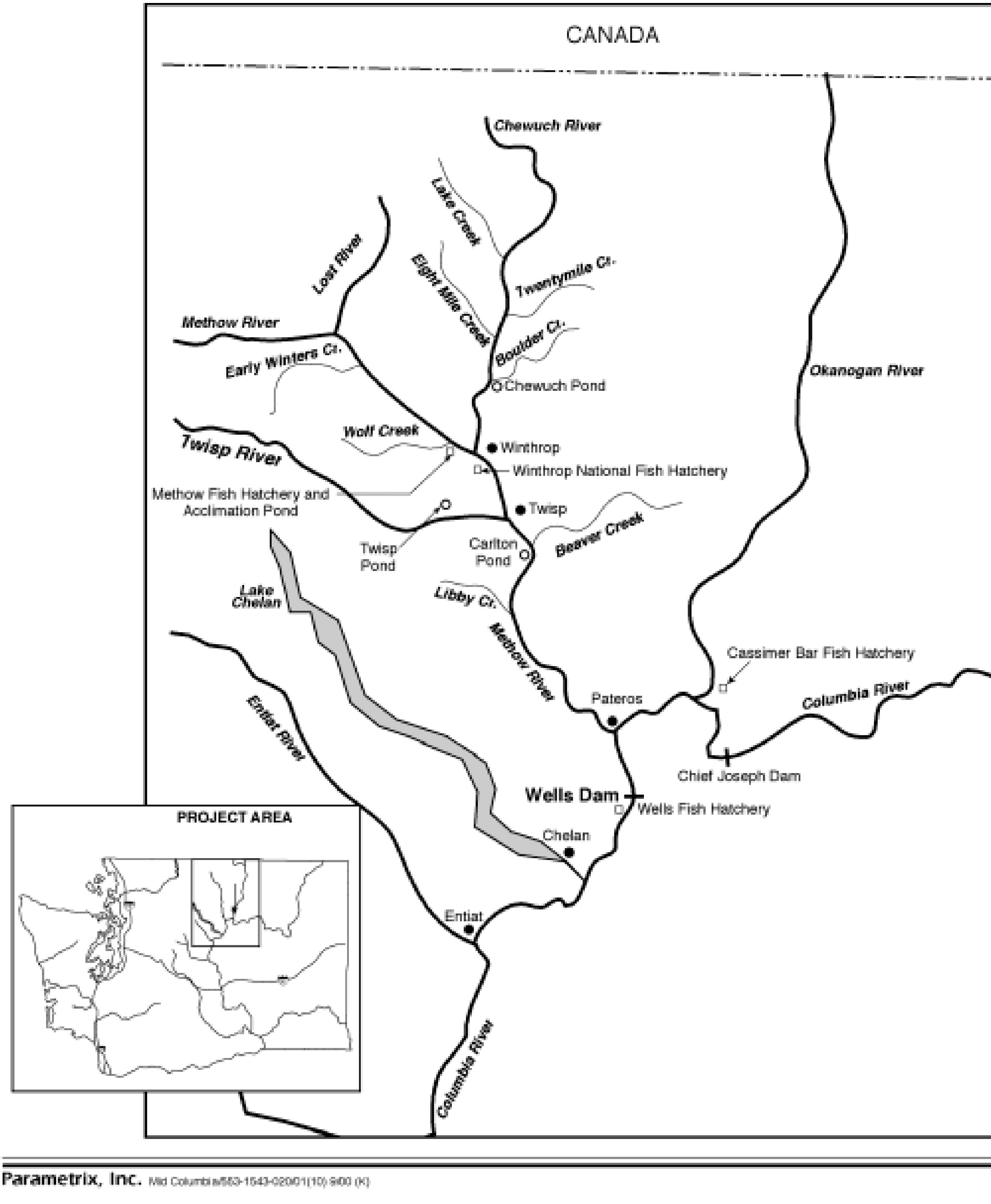
Parametrix, Inc. Mid Columbia/553-1543-020(10) 2/00 (K)

N

NOT TO SCALE

Dam
Hatchery
City

Figure 1-4
Entiat River and Associated Creeks and Fish Facilities



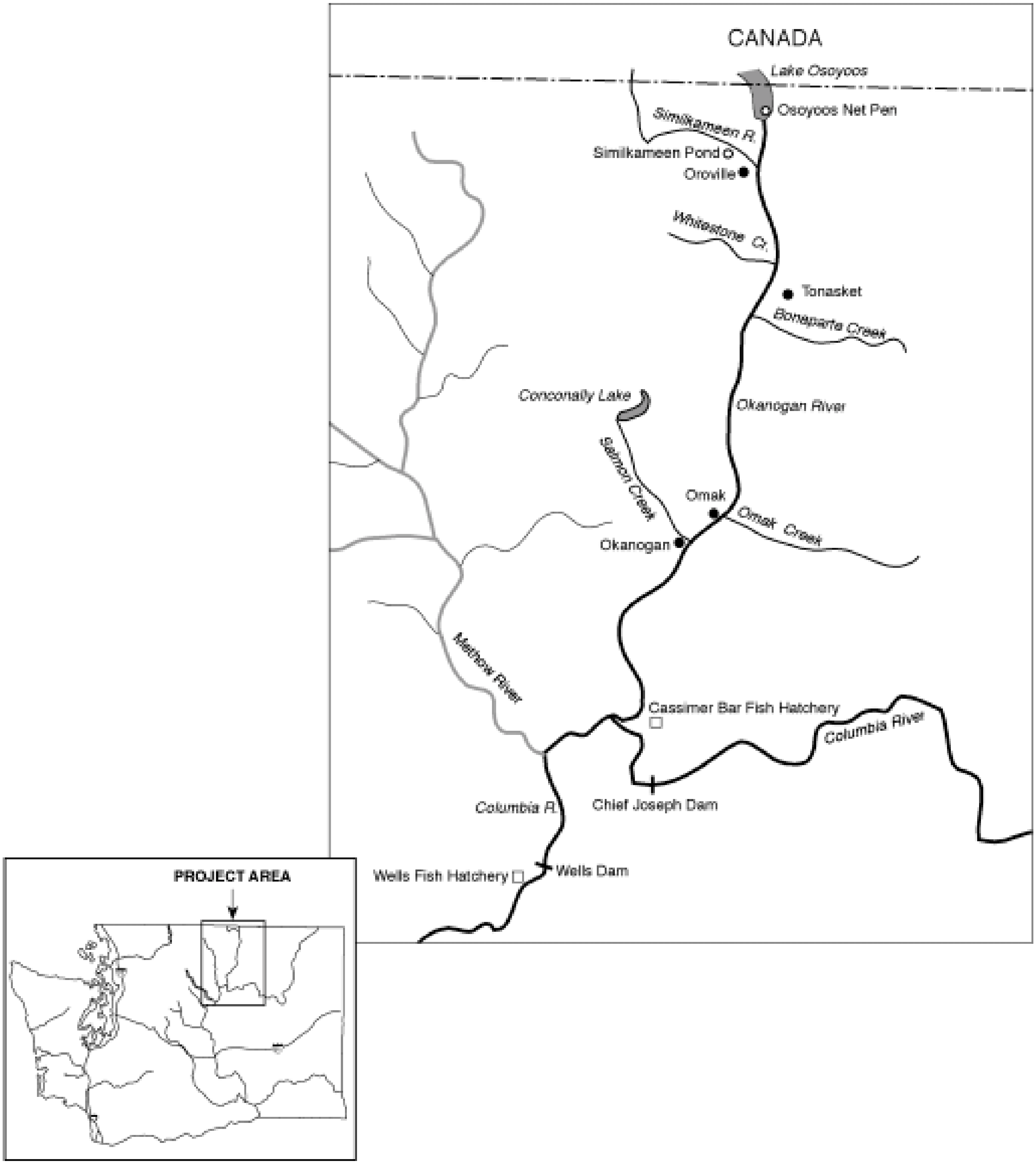
Parametrix, Inc. Mid Columbia/553-1543-020/01(10) 9/00 (K)

N

NOT TO SCALE

Dam	• City
□ Hatchery	○ Pond

Figure 1-5
Methow River and Associated Creeks and Fish Facilities



Parametrix, Inc. Mid Columbia/553-1543-020(10) 2/00 (K)

N

NOT TO SCALE

Dam
Hatchery
City
Pond

Figure 1-6
Okanogan River and Associated Creeks and Fish Facilities

Alternate U.S. Highway 97, excepting in the vicinity of the Chelan Butte Wildlife Area, where no highways are present. South of the wildlife area is Alternate U.S. Highway 97 south to Wenatchee. State Route 285 then parallels the Columbia River in the vicinity of Wenatchee, and the Malaga Aluminum Company of America (ALCOA) Highway parallels the western shore of the river south past the Rock Island reservoir.

For all three projects, there are no locks, ports, harbors, or smaller navigational channels that provide commercial boat passage between the three projects. Consequently, motor use on the river in the vicinity of the three projects is restricted to recreational use between projects.

Two railroads parallel portions of the Columbia River in the Plan area. The Burlington Northern railroad follows the western shoreline, while the Rock Island Railroad and the Burlington Northern Railroad extends along the eastern shoreline.

1.7.2 PREVIOUS AND ONGOING MANAGEMENT PROGRAMS IN THE PLAN AREA

A wide range of Federal, State, tribal, utility, and environmental parties are active in the management of the Columbia River and its adjacent resources. Literally hundreds of plans and studies have been conducted in the area. These include long-range operations plans for the hydropower projects at the system and project levels. These also include detailed scientific studies focusing on issues such as fish passage, fish habitat, water quality, or other physical elements that affect biological requirements for salmon and steelhead. For the Wells, Rocky Reach, and Rock Island projects, the FERC licenses and related documents provide an extensive record on the background of the projects and their operating characteristics, including environmental effects. Many of these documents are included as references for the HCPs and this EIS.

Other studies in the area include resource and watershed management plans developed at the State and Federal levels to comply with the requirements of the Clean Water Act, to support natural resource management initiatives (including those required by the Endangered Species Act), and to assist in water rights administration. The plans include scenic, land use, and recreational resource management studies. Also included are scientific and engineering studies conducted by NMFS, USFWS and other studies related to recovery planning, permitting, and mitigating project development. Some of these studies are directly within the HCP planning areas, while others involve issues that either affect the plan area environment or are influenced by the activities of the Mid-Columbia projects. Where appropriate, the HCPs and this EIS refer to these documents in the review of scientific information, and in the analysis of the HCPs compatibility with other plans and programs.

The following is a brief review of the entities that conduct hydropower and river-related management studies in the plan area. Where appropriate, the major activities or efforts relevant to the PUD projects and the Mid-Columbia HCPs are identified.

1.7.2.1 Federal Energy Regulatory Commission

The FERC conducts an ongoing review of State and Federal comprehensive plans for developing or conserving a waterway. This activity is part of FERC efforts to comply with the Electric Consumers Protection Act of 1986, which ordered FERC to consider each proposed project's consistency with relevant comprehensive plans. Table 1-1 is an October 1999 listing by FERC of the comprehensive plans it has identified in and around the Columbia basin.

1.7.2.2 National Marine Fisheries Service

Many of NMFS’ past studies, listings, and rules are directly relevant to the Mid-Columbia hydroelectric projects. Currently, the most significant documents, aside from the listings themselves, are NMFS's

TABLE 1-1. COMPREHENSIVE PLANS IN THE PROJECT AREA

PLAN
▪ Columbia River Basin Fish and Wildlife Program (1984, 1987, 1994), Northwest Power Planning Council
▪ Columbia River Fish Management Plan Settlement Agreement, U.S. District Court for the District of Oregon in Case No. 68-513
▪ Instream Resource Protection Program for the Mainstem Columbia River in Washington State, WDOE
▪ Northwest Conservation and Electric Power Plan, Northwest Power Planning Council
▪ Okanogan National Forest Land and Resource Management Plan, U.S. Forest Service (USFS)
▪ Protected Areas Amendments and Response to Comments, Northwest Power Planning Council
▪ Resource Protection Planning Process - Mid-Columbia Study Unit, Department of Community Development. Washington Office of Archaeology and Historic Preservation
▪ Scenic Rivers Program Report, Washington State Parks and Recreation Commission
▪ Shorelands and Coastal Zone Management Program, WDOE
▪ Shorelands and Water Resources Program - State Wetlands Integration Strategy, WDOE
▪ State of Washington Natural Heritage Plan, Washington Department of Natural Resources
▪ State Scenic River System Act, Chapter 79.72 RCW
▪ Washington State Hydropower Development/Resource Protection Plan, Energy Office
▪ Washington State Scenic River Assessment, Washington State Parks and Recreation Commission
▪ Washington's Statewide Comprehensive Outdoor Recreation Plan, Sixth Edition, Interagency Committee for Outdoor Recreation
▪ Water Resources Management Program - Methow River Basin, WDOE
▪ Water Resources Management Program - Okanogan River Basin, WDOE
▪ Water Resources Management Program – Entiat River Basin, WDOE
▪ Water Resources Management Program - Wenatchee River Basin, WDOE
▪ Wenatchee National Forest Land and Resource Management Plan, USFS
▪ Wenatchee River Basin Instream Resources Protection Program, WDOE

Source: FERC (1999)

1995 biological opinion on the Operation of the Federal Columbia River Power System, and the 1998 supplemental biological opinion for steelhead. The 1995 biological opinion was the result of a Federal ruling that ordered NMFS to reexamine a "No Jeopardy" biological opinion issued in 1993 for the system plan.

While prepared in response to a re-initiation of consultation between NMFS and the Federal system operators, the biological opinion outlined the Federal government's commitments to recover the listed species. It described an ecosystem management approach for improving the likelihood of recovery, and established the specific measures it deemed necessary for the survival and recovery of the listed species. NMFS, through the biological opinion, sought to address all sources of salmon and steelhead mortality related to the Federal hydroelectric projects. It also included measures to rebuild the stocks to meet the requirements of the Endangered Species Act and address Federal treaty obligations and trust responsibilities to the Indian people.

1.7.2.3 Bonneville Power Administration, U.S. Department of Energy

The BPA is the sole Federal power marketing agency in the Northwest and the region's major wholesaler of electricity. Created by Congress in 1937, BPA services the States of Washington, Oregon, Idaho, Montana, west of the Continental Divide, and small adjacent portions of California, Nevada, Utah and Wyoming. BPA markets and transmits power, coordinates operation of the Federal Columbia River Power System, and manages a large portion of the Pacific Northwest-Pacific Southwest Intertie. Although it lacks authority to build or own dams or power plants, BPA does own and operate, within its service area, the nation's largest network of long-distance, high-voltage transmission lines. The BPA is part of the U.S. Department of Energy, but is not funded by tax revenues; the agency recovers the cost of operations and maintenance mainly through its electricity rates.

1.7.2.4 U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers owns and operates eight Federal hydropower projects on the Columbia and lower Snake rivers. This includes the McNary, Dalles, Bonneville and John Day projects on the lower Columbia. The Army Corps of Engineers is also responsible for implementing the Columbia River Fisheries Management Program for its projects. The management program is largely based on measures contained in the March 1995 biological opinion issued by NMFS on the impacts of the Federal hydropower system operations on Snake River chinook and sockeye salmon. It also incorporates newer measures included in NMFS's 1998 supplemental biological opinion for steelhead. In addition, the Army Corps of Engineers' program considers and implements capital construction measures for mainstem fish passage.

1.7.2.5 Northwest Power Planning Council and the Columbia River Basin Fish and Wildlife Program

The Northwest Power Planning Council is a four-state compact formed under the Northwest Power Act. Through the Council, Idaho, Montana, Oregon and Washington oversee electric power system planning and fish and wildlife recovery in the Columbia River basin. The Council has no direct authority over utilities, but it works closely with Northwest utilities and State regulatory commissions. The Northwest Power Act gave the Council three distinct responsibilities: (1) to assure the region has an adequate, efficient, economical and reliable electric power supply; (2) to prepare a program to protect, mitigate and enhance fish and wildlife of the Columbia River basin that have been affected by the construction and operation of hydropower projects; and (3) to inform the Pacific Northwest public about energy issues and involve the public in decision-making.

Recent studies by the Council include a reliability study of the Northwest power system loads and resources, and a review of Columbia River basin fish and wildlife decision-making processes. One of the Council's largest ongoing programs is the Columbia River Basin Fish and Wildlife Program, which was last adopted in 1995, with an update currently underway.

The basin fish and wildlife program was the first comprehensive strategy for fish and wildlife in the Columbia River basin. The Northwest Power Act required the plan to address the following issues: (1) environmental quality, (2) compatibility with the existing regional power system, and (3) protection, mitigation, and enhancement of fish and wildlife and related spawning grounds and habitat (including sufficient quantities and qualities of flows for successful migration, survival, and propagation of anadromous fish). The four key directives in the Council's fish and wildlife program regarding anadromous fish are to improve migration survival, reduce harvest, protect and improve habitat, and improve hatcheries.

1.7.2.6 Fish Passage Center

The Fish Passage Center is an entity established by the Northwest Power Planning Council's Fish and Wildlife Program, with funding provided by BPA. The Fish Passage Center participates in coordinating river flows for fish migration at mainstem Columbia and Snake river hydroelectric projects, both Federal and non-federal. The Fish Passage Center provides technical support and data for the agencies and tribal members in planning and implementing operation of the hydroelectric system.

It provides extensive data on flow and passage mitigation measures related to the Council's Fish and Wildlife Program and NMFS biological opinions.

1.7.2.7 Bureau of Indian Affairs, U.S. Department of the Interior

The Bureau of Indian Affairs (BIA) is charged with carrying out the major portion of the trust responsibility of the United States to Native American Indian Tribes. This trust includes the protection and enhancement of Indian lands and natural resources through technical assistance and management and mineral resource management.

1.7.2.8 Bureau of Land Management, U.S. Department of the Interior

The BLM is responsible for the management of 114 million hectares of public lands located primarily in the far west and Alaska. Resources managed by BLM include timber, hard minerals, oil and gas, geothermal energy, wildlife habitat, endangered plant and animal species, rangeland vegetation, recreation and cultural values, wild and scenic rivers, designated conservation and wilderness areas, and open space. The Hanford reach, located downstream of Priest Rapids project, has been designated a historical monument. Some of the lands adjacent to the Mid-Columbia reach are also Federal public lands managed by BLM.

1.7.2.9 Bureau of Reclamation, U.S. Department of the Interior

The BOR administers Federal programs in the 17 western States for water resource management, and owns and operates a number of dams in the Northwest including Grand Coulee Dam north of the Mid-Columbia projects. It also owns and operates several projects on the tributaries of the Columbia River.

1.7.2.10 U.S. Environmental Protection Agency

The U.S. Environmental Protection Agency (USEPA) is responsible for managing and enforcing water quality regulations in the nation's waters. It also regulates discharge of pollutants into water and air. Under the Clean Water Act, USEPA, the State, tribal governments, other Federal agencies, and private landowners will implement numerous programs throughout the Columbia River basin to improve water quality in associated watersheds and tributaries. These programs will be implemented in the mainstem and tributaries and will focus on improving water quality, restoration of habitat, and recovery of Endangered Species Act-listed species. In the state of Washington, the Washington Department of Ecology has been charged by the USEPA to implement the provisions of the Clean Water Act.

1.7.2.11 Columbia Basin Fish and Wildlife Authority

The authority is an association of the fish and wildlife agencies from the four states, the two Federal agencies and 12 Indian Tribes in the Columbia River basin. Its mission is to coordinate planning and implementation of the fish and wildlife management issues in dealings with the Northwest Power Planning Council, BPA, and the Army Corps of Engineers. It is a non-regulatory party, and presents only consensus positions of its members.

1.7.2.12 Columbia River Inter-Tribal Fish Commission

This commission represents Columbia basin Indian Tribes that signed treaties in 1855 securing to them certain reserved rights to take fish in the Columbia River and its tributaries. The Commission is composed of the fish and wildlife committees of its member Tribes and supplies technical expertise and enforcement resources.

1.7.2.13 Columbia River Treaty Tribes

Four Columbia River basin Tribes have reserved rights to anadromous fish, provided through an 1855 treaty with the United States. The four treaty Tribes are the Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Confederated Tribes and Bands of the Yakama Indian Nation. A fifth tribal organization, the Confederated Tribes of the Colville Indian Reservation, was not specifically named in the 1855 treaty, but the Colville confederation includes the Nez Perce Tribe.

From 1905 through the present, a series of Congressional Acts and Federal court rulings have clarified tribal treaty fishing rights, and determined the various responsibilities of State and Federal agencies to co-manage basin resources with the Tribes and regulate treaty fisheries for conservation purposes. Below, the Tribes are briefly described, based on information provided by the Columbia River Inter-Tribal Fish Commission. Summary information on the Tribes is followed by a listing of tribal settlements and agreements involving the Wells, Rocky Reach, and Rock Island projects.

The Nez Perce Tribe

The Nez Perce homeland once covered 5 million hectares in what is now Idaho, Oregon, and Washington. Today, the reservation consists of 741,300 acres, of which 13 percent is owned by the Tribe. The Nez Perce co-manage and fish in several Columbia River basins, including the mainstem Columbia. The Tribe has an enrolled membership of about 3,000 and is headquartered in Lapwai, Idaho.

The Confederated Tribes of the Colville Reservation

The reservation of the Confederated Tribes of the Colville was established by President Grant's Executive Order in 1872. The 12 Tribes located there are the Okanogan, Lakes, Colville, San Poli, Nespelem, Methow, Entiat, Chelan, Wenatchee, Moses-Columbia, Palouse, and the Nez Perce. The 1,397,500 acre reservation in the north central section of Washington State is bounded on the east and south by the Columbia River and on the west by the Okanogan River.

The Confederated Tribes and Bands of the Yakama Indian Nation

The Yakama Indian Nation includes 14 bands and Tribes, including the Kah-milt-pah, Klickitat, Klinquit, Kow-was-say-ee, Li-ay-was, Oche-chotes, Palouse, Pisquose, Se-ap-cat, Shyiks, Skinpah, Wenatshapam, Wishram, and Yakama. The 1,185,000-acre Yakama Indian Reservation is in south central Washington. The Yakama Indian Nation co-manages the Columbia River, as well as the Wind, White Salmon, Klickitat, Yakima, Wenatchee, Methow, Entiat and Okanogan rivers, and fishes in many locations in the greater basin.

The Confederated Tribes of the Umatilla Indian Reservation

The confederation of the Walla Walla, Cayuse, and Umatilla Tribes shared a homeland in what is now northeastern Oregon and southeastern Washington. Today the three-Tribe confederation numbers 1,500, and much of the tribal reservation is in the Umatilla and Grande Ronde River watersheds in Oregon. The Tribe has co-management responsibilities for several Columbia basin rivers, including the mainstem Columbia. Most of its fishing and conservation activities occur along the Umatilla, Grande Ronde, and Columbia rivers, below the confluence of the Snake and Columbia rivers.

The Confederated Tribes of the Warm Springs Reservation of Oregon

The three Tribes in this confederation are the Warm Springs, Wasco and Paiute, and the Tribal headquarters are in Warm Springs, Oregon. The Warm Springs Tribe co-manages the Columbia, Deschutes, Fifteenmile Creek, John Day and Hood River watersheds, but is typically not an active participant in the management of the Mid-Columbia reach. However, their fishing activities are affected by the health of Mid-Columbia stocks.

1.7.3 Other Contracts and Agreements

1.7.3.1 Mid-Columbia PUD FERC Agreements

The licenses for the three Mid-Columbia hydroelectric projects include agreements with Columbia basin tribal nations, State and Federal fisheries agencies, and major contracted power purchasers. The agreements address such issues as juvenile fish passage, hatchery operations, and project modifications and studies related to anadromous fisheries. For the Rock Island project, the Chelan County PUD has entered into an agreement with the Confederated Tribes of the Colville Indian Reservation, the Confederated Tribes of the Umatilla Reservation, and the Confederated Tribes and Bands of the Yakama Indian Nation. However, the agreement for the Rocky Reach Project (4th Revised Interim Stipulation) has expired. The Douglas County PUD has also entered into agreements with these same entities for the Wells project.

1.7.3.2 Major Bond and Sales Agreements for the Projects

The projects owned by the Chelan and Douglas County PUDs have different development and financing histories. However, long-term bonds and sales contracts are two major elements affecting their operations, and the major reason why the district's are seeking an HCP agreement with a 50-year term. Uncertainty about the effects of Endangered Species Act issues on the projects could affect the districts bond ratings and their ability to enter future long-term sales contracts.

Through long-term contracts, Chelan County PUD sells about 63 percent of its hydroelectric power at cost to utilities in the Northwest. The district finances its hydropower projects through bonds dedicated to each project, and through consolidated bond offerings that also fund its power distribution and water/wastewater systems. The Douglas County PUD sells about 62 percent of its power through long-term contracts. The major financing bonds and sales contracts for the PUDs and their projects are described below.

The Rocky Reach project was developed and financed by Chelan County PUD through the sale of revenue bonds, which pledged revenues from the project for debt repayment. The original project was financed with $273.1 million of revenue bonds in 1956 and 1957; by 1998, both issues had been repaid or refinanced. Additional project improvements for generation, recreation, fish protection and other features have also been financed by revenue bonds; as of 1999, $18 million in bonds were outstanding.

The repayment of the revenue bonds has been guaranteed through power sales contracts between Chelan County PUD and Pacificorp, Portland General Electric Company, Puget Sound Energy, Inc. (formerly Puget Sound Power & Light), Avista Corporation (formerly Washington Water Power Company), the ALCOA, and the District's electric distribution system. Most of the contracts cover a 50-year period that started after the November 1961 date of commercial operation, and they expire in October 2011. The current contracts for Rocky Reach allow the district only to recover production costs, but it can sell its excess power at market rates (Chelan County PUD 1999e)

The Rock Island project was first developed by Puget Sound Energy in 1930, and was purchased by Chelan County PUD in 1956. A second powerhouse was added to the project in 1979. The district has issued several series of bonds to purchase, expand and improve the project, and as of 1999 had $316 million in bonds outstanding. All of the power from the project is sold to Puget Sound Energy and to the district's distribution system (Chelan County PUD 1999e).

The Douglas County PUD began developing the Wells project in 1963, and completed the project in 1967. The development was funded through revenue bonds. In 1975, 1986, 1990 and 1993, additional bonds were issued for various project improvements and to fund programs required under the project's license and other agreements. As of 1999, the PUD had $168.7 million in bonds outstanding. Through long-term sales contracts that continue to 2018, 100 percent of the power generated by Wells is sold to Pacificorp, Puget Sound Energy, Portland General Electric Company, Avista Corporation, and the District's distribution system. In addition, the District has a power sales contract with the PUD No. 1 of Okanogan County, which entitles Okanogan PUD to an 8 percent interest in the project after all acquisition and construction debts are repaid, which is expected to occur in October 31, 2017. The remaining 92 percent will be owned by Douglas County PUD. The contracts allow the district to recover production costs for the Wells project.

1.8 SCOPE OF THE ENVIRONMENTAL IMPACT STATEMENT

Public scoping for the environmental review of the permit applications began with publication of a Notice of Intent in the Federal Register on January 6, 1999. Subsequently, a scoping brochure was distributed to all parties requesting additional information after the Notice of Intent was published, as well as to individuals, agencies, businesses or organizations known to have an interest in the hydroelectric projects, the HCPs, or other aspects of the study area. The mailing list included over 285 individuals, agencies, private businesses, and organizations. Both the Notice of Intent and the brochure described the project's public scoping period, which lasted through February 5, 1999. The brochure included notice of project scoping meetings, and notices of the meetings were also advertised in local newspapers.

Scoping meetings were held on January 20, 1999 in Wenatchee, Washington and on January 21, 1999 in Brewster, Washington. Spoken comments were solicited at the meetings, and written comments were received throughout the scoping period. Additional resource agency comments were also received as a result of a scoping and alternatives development meeting held on March 3, 1999. Using results from the scoping meetings, NMFS and the project applicants refined the scope of the projects and alternatives.

The meetings also helped highlight areas of special concern, which included environmental protection, Endangered Species Act compliance, and impacts to society and economic conditions. Comments included alternative preferences, monitoring and measurement, and cultural resources, as well as requests for additional information on the regulatory context and requirements for hydropower project licensing, and implementation and interpretation of the no surprises policy. Following development of the alternatives, a cooperating and participatory agency/organization meeting was held on September 9, 1999 to describe the alternatives and scoping comments received.

1.8.1 TEMPORAL SCOPE

The period of time covered by the EIS analysis of direct and cumulative effects includes present and future actions and their effects on each resource. For the purpose of this analysis, the temporal scope will look 50 years into the future, which is the term of the HCP agreements. The scope of the analysis does not consider impacts or damages related to past project construction. This 50-year time frame for the HCPs was selected by the PUDs because of the high costs involved with HCP negotiation, species research, permit/document preparation, and ongoing monitoring. An HCP term less than 50 years would be at a significantly greater cost over the lifetime of the agreement considering the initial large HCP preparation expenses.

1.9 DECISION TO BE MADE

The proposed action (Alternative 3) is the preferred alternative by the project proponents (Douglas County and Chelan County PUDs). NMFS will select the Federal agency's preferred alternative in a Record of Decision (ROD) that will be issued by NMFS after the completion of this EIS and following the subsequent public review and comment period. There are several key steps that NMFS must also take before deciding on the applicants' request for a Section 10 incidental take permit. The actions by NMFS will be guided by both the Endangered Species Act and NEPA requirements. The major NEPA-related issues that NMFS must consider in making its decision are:

- Was the environmental review process adequate?
- Were the impacts adequately discussed, and will significant adverse impacts be mitigated?
- Were all reasonable and appropriate alternatives to the proposed action considered?
- Are there significant unavoidable adverse impacts?
- What were the values that were considered, and what is the basis for the decision?
- Are there any outstanding unresolved issues?
- Will the proposed action result in the irrevocable commitment of Federal resources?

The major Endangered Species Act issues that NMFS must consider are related to the overall protection and recovery of the salmon and steelhead species that would be covered by the incidental take permit. To document its analysis and decision making, NMFS will prepare a biological opinion to determine if the implementation of the HCPs is likely to jeopardize the continued existence of listed species that are likely to occur in the Plan area. The analysis by NMFS will involve:

- Defining the species-level biological requirements,
- evaluating the species status with respect to the species-level biological requirements,
- determining the biological requirements within the proposed action area,
- determining the status of the species within the action area,
- determining the factors affecting the species environment within the action area,
- determining the effects of the proposed action on species-level biological requirements,
- evaluating the cumulative effects associated with the proposed action,
- identifying critical habitat for the species,
- determining whether the species can be expected to survive with an adequate potential for recovery under the proposed action, and
- identifying reasonable alternatives to the proposed action if it is likely to jeopardize listed species.

If the NMFS' biological opinion finds that the proposed actions are not likely to jeopardize the continued existence of the listed species and not likely to result in the destruction or adverse modification of critical habitat, the permits can be approved. Any additional measures that NMFS deems necessary for the permit would be detailed in the biological opinion. The ROD will certify the adequacy of the HCPs environmental review process, and it will incorporate the requirements of the permit, including the requirements in the biological opinion and the mitigation commitments of the applicants. It will also include a summary of the responses to comments on the EIS.

Alternatively, if incidental take permits are not authorized under Section 10 (a)(1)(B) of the Endangered Species Act, the FERC may seek coverage from Section 9 take prohibitions through consultation with NMFS or the PUDs may challenge NMFS' decision or file new Section 10 permit applications.

1.10 BACKGROUND SUMMARY

In late 1993, three Washington State PUDs (Chelan, Douglas, and Grant) began the process of developing eco-system based plans to manage the fish and wildlife that inhabit the Mid-Columbia River basin and it's tributaries (from the tailrace of the Chief Joseph Dam at river mile 545 on the Columbia River to the confluence of the Yakima and Columbia rivers at river mile 335). By 1998, when final plans were submitted to NMFS as applications for incidental take permits under Section 10 (a)(1)(B) of the Endangered Species Act, many State and Federal resource agencies, Tribes, and American Rivers, had participated in their development.

NMFS is currently evaluating how Endangered Species Act-listed species and other natural resources would be affected by the specific measures contained within the HCPs. Therefore, this EIS is being developed for the purpose of disclosing the information relevant to the plans such that environmental consequences resulting from implementation of the HCPs can be considered by NMFS when determining whether or not to issue incidental take permits.

The final HCPs submitted to NMFS are specific to three hydroelectric projects on the Mid-Columbia River, the Wells project owned and operated by PUD No. 1 of Douglas County, and the Rocky Reach and Rock Island projects owned and operated by PUD No. 1 of Chelan County. Although the plans initially included the Priest Rapids Project, owned and operated by PUD No. 2 of Grant County, this PUD has since withdrawn as a participant. In addition, the original eco-system based management approach was abandoned as overly ambitious in favor of HCPs that focus specifically on the five Plan species.

The objective of the HCPs is to achieve 100 percent no net impact for each Plan species affected by the Wells, Rocky Reach, and Rock Island hydroelectric projects. If NMFS determines that the HCPs satisfy the requirements of Section 10 (a)(1)(B) of the Endangered Species Act, then individual incidental take permits would be issued for each project. Alternatively, if incidental take permits are not authorized, FERC may seek coverage from Section 9 take prohibitions through consultation with NMFS or the PUDs may challenge NMFS' decision or file new Section 10 permit applications.

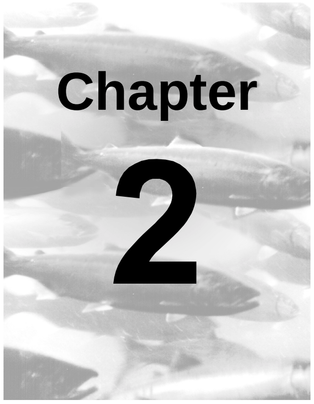
Based on the status of endangered anadromous salmonid species within the action area and results of the QAR analyses, continuing with the status quo (i.e., project operations as described in the existing settlement agreements and FERC licenses) results in a high likelihood that the species will not survive into the future. Therefore, the no-action alternative is not a viable option.

The HCPs are designed to minimize and mitigate the impacts to protected species from the operation of the three hydropower projects. The plans include measures specific to each of the projects, but they also feature overall standards for salmon and steelhead protection at the three projects. The agreements establish a survival standard of 91 percent for the Plan species (adults and juveniles) passing through the geographic area of each project. In addition, there would be an independent standard of 95 percent juvenile dam passage survival for each of the Plan species at each project .

The utilities would compensate for the 9 percent fish loss at the projects through a hatchery and tributary habitat fund. Hatcheries would compensate for 7 percent of fish mortality at the projects. Habitat improvements in the Columbia

River tributaries would compensate for the remaining 2 percent mortality. This compensation for project mortality would result in a no net impact standard at the three projects. Currently, the mitigation for ongoing fish losses at the projects is provided by hatchery programs.

A key part of the HCP agreements is an "adaptive management" approach that would allow Coordinating Committees to jointly determine how to manage project operations and HCP activities to meet the HCP standards. The utilities, State and Federal resource agencies, Tribes and American Rivers would be represented on the Coordinating Committees and would monitor implementation of the HCPs if each signs the HCP agreements. Douglas County and Chelan County PUDs would have separate Coordinating Committees for the Wells and Rocky Reach/Rock Island projects, respectively. Under the agreement, the utilities would have the ultimate authority in the decision making process, as long as the no net impact standards are being met. If all parties agree that the standards have not been achieved, the Coordinating Committees would have an increased role in the decision making process.



Chapter 2 Alternatives

Chapter

2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

Key Terms

FERC License - A Federal license for hydroelectric projects that includes requirements and restrictions about how the projects are maintained and operated. The PUD hydroelectric projects are licensed by the FERC, under the Federal Power Act.

Fish Passage Facilities - The features of a dam that enable fish to move around, through, or over a dam without harm. Facilities generally include an upstream fishladder and/or a downstream bypass system. A fishladder is a series of ascending pools constructed to enable salmon or other fish to swim upstream past the dam or barrier. A bypass system is a structure that provides a route for fish to move through or around the dam without going through turbine units that are the primary source of fish mortality at a dam.

Run-of-the-River Hydroelectric Project - The Wells, Rocky Reach, and Rock Island hydroelectric projects are run-of-the river projects, which means that they do not store substantial amounts of water in their reservoirs. Run-of-the-river hydroelectric projects produce electric power through use of the gravitational force of falling water, and consist of a powerhouse, spillway and embankments, as well as fish passage facilities.

No Net Impact - An objective of the HCPs is to achieve 100 percent No Net Impact for each Plan species affected by the Wells, Rocky Reach, and Rock Island hydroelectric projects. The No Net Impact standard consists of two primary components: ninety-one percent project passage survival, achieved within the geographic area of the projects, and a nine percent compensation for unavoidable project mortality. The utilities would compensate for the 9 percent fish loss at the projects through a hatchery and tributary habitat fund. Hatcheries would compensate for 7 percent of fish mortality at the projects. Habitat improvements in the Mid-Columbia River tributaries would compensate for the remaining 2 percent mortality. This compensation for project mortality would result in a No Net Impact standard at the three projects.

Settlement Agreement - Protection plans developed through negotiations with the fishery agencies and Tribes that specify mitigation and compensation measures for the impacts to anadromous fishery resources as a result of project operations. The fish protection agreements for the Wells, Rocky Reach, and Rock Island projects are documented in the 1990 Wells Long-Term Settlement Agreement, the 1994 Fourth Revised Rocky Reach Interim Stipulation (expired), the 1987 Rock Island Settlement Agreement, and the Vernita Bar Agreement.

* *See Chapter 6 for a complete listing of all Key Terms.*

This chapter summarizes alternatives to address Endangered Species Act requirements for listed species affected by operation of the Wells, Rocky Reach, and Rock Island hydroelectric projects. The three alternatives considered for the projects are discussed and compared on a general level in this chapter, and presented in more detail in Chapter 4. Specifically, this chapter explains:

- How the alternatives were developed,
- the existing hydroelectric projects and related fisheries issues,
- alternatives considered in this EIS,
- the common and the unique features of the alternatives,
- alternatives eliminated from detailed evaluation, and
- comparative differences between the alternatives.

2.1 DEVELOPMENT OF ALTERNATIVES

Upper Columbia River steelhead and spring-run chinook salmon were listed as endangered under the Endangered Species Act in 1997 and 1998, respectively. The alternatives examined in this EIS include a no-action alternative and two action alternatives for obtaining Federal approval to impact these endangered species.

Hydroelectric projects have the potential to impact steelhead and spring-run chinook salmon through the direct and indirect effects of project operations, and due to changes in habitat that result from project operations. As a result, an incidental take of either of these species may occur. An 'incidental take' of a listed species is any take that results from, but is not the purpose of an otherwise lawful activity. Take, as defined in Section 9 of the Endangered Species Act, is to harass, harm, pursue, hunt, shoot, wound, trap, capture, collect or attempt to engage in any such conduct. Under the terms of Section 7 (b)(4), Section 7 (a)(2), and Section 10 (a) of the Endangered Species Act, a take is not prohibited provided that it is in compliance with the terms and conditions of either a biological opinion (Section 7) or an incidental take permit (Section 10).

A biological opinion is the result of consultations that occur between Federal agencies pursuant to Section 7 of the Endangered Species Act. An incidental take permit is issued for non-Federal actions according to Section 10. Because the Wells, Rocky Reach, and Rock Island hydroelectric projects were issued Federal operating licenses by FERC, this agency is required to consult with NMFS under Section 7 in order to obtain legal coverage from the Section 9 take prohibitions.

Under this process, FERC would identify the potential incidental take of listed species that may result from continuing project operations. They would then suggest measures to protect the species to the extent possible and describe how these measures would be implemented. The NMFS would then prepare a biological opinion to determine if the proposed actions and associated protection measures were sufficient to prevent take to the extent that the species would not be in jeopardy of extinction.

A "no jeopardy" biological opinion would be issued only if the NMFS biological opinion determines that the actions is not likely to jeopardize the continued existence of the listed species or cause the destruction or adverse modification of critical habitat, and that there is adequate potential for recovery of listed species when the proposed protection measures are implemented. If NMFS determines that the proposed measures are not adequate to ensure the continued existence of the species, a reasonable and prudent alternative to the proposed action would be developed. The measures developed by NMFS, and the terms and conditions or reasonable and prudent alternatives are mandatory requirements of the biological opinion. To be in compliance with the take prohibitions of Section 9, FERC would implement the measures identified in the biological opinion by modifying the associated operating licenses. However, modification of a FERC license is subject to appeal by the licensee.

The reasonable and prudent measures or alternatives and the terms and conditions of the biological opinion would remain in effect as long as new information did not indicate that the species continued existence was in jeopardy. If new information did show that the species was declining or that there were other adverse effects associated with project operations, FERC would reinitiate consultation with NMFS and additional measures would be implemented as necessary.

Non-Federal applicants can apply for a special exemption to the take prohibitions by utilizing the Section 10 permitting process. The Section 10 process requires applicants to develop a conservation plan specifying, among other things, impacts that are likely to result from their proposed actions, and defining the measures that would be taken to minimize and mitigate for the impacts. Conservation plans under the Endangered Species Act are also known as habitat conservation plans (HCPs). A biological opinion from NMFS would still be required and would determine if an incidental take of a species, considering the applicant's HCP measures, would cause jeopardy or adverse harm to the listed species, to any additional proposed HCP Permit species, or to their critical habitat.

This EIS examines the Federal and non-Federal alternatives for complying with the Endangered Species Act. Alternative 2 involves the Section 7 process, where FERC consults with NMFS on decisions related to reasonable modifications of the project structures or operations, or other plans that may affect listed species. Alternative 3 utilizes the Section 10 process for non-Federal applicants (HCP approach). This alternative would provide incidental take permits to Chelan and Douglas County PUDs for the implementation of their HCPs.

Alternative 2 applies only to species currently listed. The HCP approach in Alternative 3 includes protection programs for the two species currently listed and additional Plan species. Protection measures for other anadromous fish species under Alternatives 1 and 2 (and under Alternative 3 to a certain extent) would be included in existing settlement agreements and FERC license articles. Additional measures may also be included in future relicensing procedures.

A 50-year time period, based on the 50-year implementation period of the HCPs, has been used in this EIS for comparison of the alternatives. Over the course of this 50-year period, project relicensings and specific reopener clauses would be used under Alternatives 1 and 2 to address the effects of project operations on anadromous salmonids. Under Alternative 3, the terms and conditions of the HCPs would address the effects of project operations on anadromous salmonids.

Over the 50-year time period, possible changes to the project area include: (1) more species could be listed, (2) spring-run chinook salmon and/or steelhead could be delisted due to the overall success of the protection measures implemented by the PUDs, State and Federal agencies, private entities and/or improved total life-history survival conditions, or (3) listed-fish populations could continue to decline.

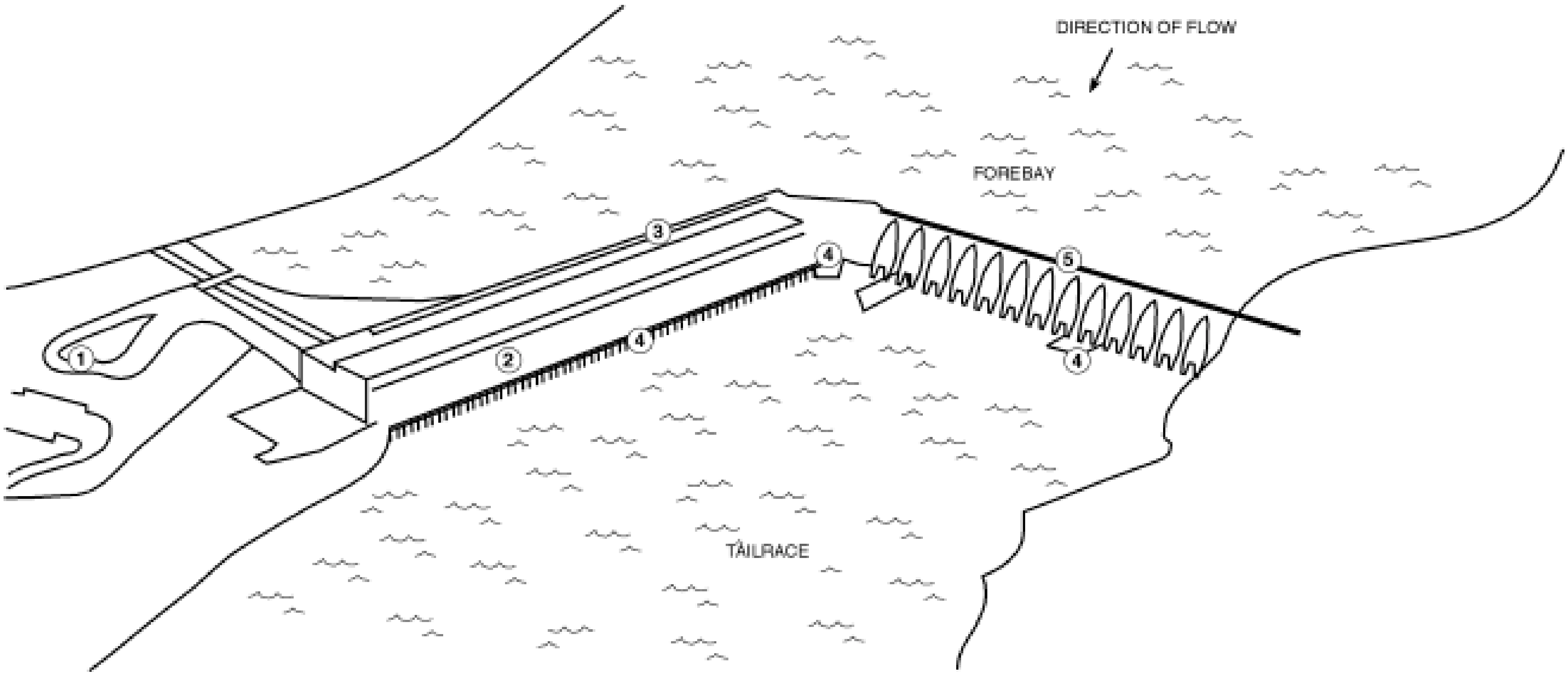
2.2 PROJECT DESCRIPTION

2.2.1 PHYSICAL FEATURES

The Wells, Rocky Reach, and Rock Island hydroelectric projects are run-of-the river projects, which means that they do not store substantial amounts of water in their reservoirs compared to the larger storage projects like the Chief Joseph or Grand Coulee dams upstream. Each project consists of a powerhouse, spillway, and embankments. The reservoir area immediately upstream of each powerhouse and spillway is called the forebay, while the tailrace is on the downstream side of the project (Figure 2-1). The upper limit of each reservoir encroaches upon the tailrace of the next project upstream (Table 2-1).

2.2.1.1 Wells Dam

Until the early 1990s, the Wells Dam was the only dam in North America designed as a hydrocombine. While traditional dams have separate powerhouse and spillway structures, the Wells hydrocombine integrates the two by placing the spillway openings in unused space between the generators. The dam spans 4,460 feet, with the hydrocombine structure comprising 1,130 feet (Table 2-2). Generating facilities consist of 10 Kaplan turbines. The hydrocombine structure contains 11 spill bays interspersed between the turbine units. Each spill bay is 46 feet wide. The upstream passage facilities at Wells Dam consist of identical but mirror-image



(1) Fish Ladder - Migratory fish swim upstream from pool to pool around the dam to their spawning grounds.

(2) Power House - Contains generating units, control room, administrative offices, as well as visitor galleries and exhibits.

(3) Main Power Transformers and Take Off Structures - Electrical energy from each generator travels to a main power transformer where the voltage is increased from 15,000 to 230,000 volts. Transmission lines supported by the take off structures carry power across the river to the switchyard.

(4) Fish Collection Entrances - The three entrances to the upstream fish transportation system are located in the spillway, center dam and along the downstream face of the powerhouse.

(5) Spillway - Is composed of regulating gates and is divided by the center fish collection entrance.

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Figure 2-1
Typical Features of Each Dam

TABLE 2-1. RESERVOIR FEATURES OF THREE MID-COLUMBIA RIVER HYDROPOWER PROJECTS

FEATURE	WELLS	ROCKY REACH	ROCK ISLAND
Reservoir common name	Lake Pateros	Lake Entiat	Rock Island
Owner	Douglas County PUD	Chelan County PUD	Chelan County PUD
Type of operation	Run-of-river	Run-of-river	Run-of-river
Dam location (river mile)	515.8	474.5	453.4
Upper limit of reservoir	Chief Joseph	Wells	Rocky Reach
Length (miles)	30	43	21
Miles of shoreline	100	93	43
Surface area (acres)	10,280	9,685	3,447
Useable storage (thousand acre-feet)	<300	<430	<100
Normal full pool elevation (feet)	781	707	613
Normal low pool elevation (feet)	771	703	609
Operating fluctuation (feet)	10	4	4
Maximum pool elevation (feet)	791	710	619
Minimum pool elevation (feet)	767	703	602.9
Annual median flow (thousand cubic feet per second [kcfs])	109	111	115

TABLE 2-2. STRUCTURAL FEATURES OF THREE MID-COLUMBIA RIVER PUD PROJECTS

FEATURE	WELLS	ROCKY REACH	ROCK ISLAND
Generating Facilities			
Total (peak) generating capacity (megawatts)	840	1,287	660
Dam configuration	Hydrocombine	Conventional	Conventional
Length (feet)			
– Left embankment	1,027	120	590
– Right embankment	2,300	460	–
– Powerhouse 1	1,130	946	870
– Powerhouse 2	–	–	470
– Spillway	(see Note 1)	740	1,184
Turbine Quantity	10	11	18
Turbine Type	Kaplan	Fixed-blade prop. (3) Kaplan (8) (see Note 2)	Fixed-blade prop. (4) Kaplan (6) Bulb (8)
Spill gate quantity	11	12	31
Spill gate type	Leaf (2 each)	Tainter	Leaf (2 or 3 each gate)
Water depth at spill gate (feet)	75	57	32-57 (see Note 3)
Spillway energy dissipaters	Yes	Yes	No
Sluice gates	2	None	None
Height of sluice freefall (feet)	70	–	–
Fish Passage and Protection Facilities			
Fishladders	2	1	3
Adult collection channel	Yes	Yes	Yes
Adult counting stations	Yes	Yes	Yes
Juvenile bypass facilities	Yes	(see Note 4)	(see Note 5)
Tailrace predator control wiring	Yes	Yes	Yes
Fish Production Facilities			
Associated hatcheries	Wells Methow Cassimer Bar	Chelan Rocky Reach	Eastbank

1. The spillway of Wells' hydrocombine is located vertically above the turbine intakes.
2. Rocky Reach turbines currently in the process of being replaced.
3. Rock Island has a range of spillway crest elevations.
4. Prototype surface collection bypass facility is installed and being tested.
5. Gatewell orifice and collection channel at Powerhouse 2.

left and right bank fishway facilities. Each fishway is a conventional pool and weir fishladder.

2.2.1.2 Rocky Reach Dam

The Rocky Reach Dam is a traditional hydroelectric project with separate powerhouse and spillway structures. The dam spans 2,460 feet, with the powerhouse comprising 1,090 feet and the spillway comprising 740 feet. There are 11 turbines at Rocky Reach Dam, providing the total nameplate generating capacity of 1,213 megawatts and a total hydraulic capacity of 217,500 cubic feet per second (cfs). Units 1 through 7 are currently vertical shaft Kaplan turbines installed during the original construction in 1962, while fixed-blade propeller turbines were installed at Units 8 through 11 in 1971. One of these fixed-blade propeller units has been replaced with a Kaplan turbine unit, and the other three units are scheduled to be replaced by 2003. In addition, all but one of the original Kaplan units have been replaced with more efficient Kaplan turbines, which are expected to increase juvenile fish passage survival.

The spillway structure at Rocky Reach Dam contains 12 spill bays. Each spill bay is 50 feet wide, for a net spillway width of 600 feet. The Rocky Reach Dam is equipped with a single adult fishway system. There are four general areas where upstream migrating fish can enter the adult fishway system: at the right end of the powerhouse, at the left end of the powerhouse, at the spillway fishway entrance, and at the powerhouse fish collection channel.

2.2.1.3 Rock Island Dam

The basic configuration of Rock Island Dam is that of a traditional hydroelectric project with separate powerhouse and spillway structures. However, Rock Island Dam is somewhat atypical in that there are two powerhouses, one each at the left and right banks. The dam spans a total of 3,115 feet, with Powerhouse 1 comprising 871 feet, Powerhouse 2 comprising 470 feet, the spillway comprising 1,185 feet, and the left abutment wall comprising 590 feet.

There are currently 18 turbine units and one station service unit at Rock Island Dam, providing a total hydraulic capacity of 220,000 cfs. The original construction in the 1930s installed Nagler turbines in Units 1 to 4 of Powerhouse 1. The second class of turbines at Rock Island Dam consists of Kaplan turbines. These units were installed as Units 5 through 10 in Powerhouse 1, coming online during the period from 1952 to 1953. The third class of turbines at Rock Island Dam consists of bulb turbines. Eight bulb turbines were installed as part of the Powerhouse 2 construction project, coming on line in 1979. Upstream passage facilities at Rock Island Dam are composed of three conventional pool and weir fishladders.

2.2.2 DAM AND RESERVOIR OPERATIONS

The three mainstem Mid-Columbia River projects reviewed in this EIS were built to produce power. Collectively, the three dams generate over 14 billion kilowatt-hours annually, or nearly 6 percent of the entire hydropower output in the United States.

Operation of these projects, however, must also take into account the diverse interests of a broad spectrum of agencies and river users.

In general, the three dams are operated to meet instantaneous demands for power. The projects produce varying amounts of power throughout a typical 24-hour period, with typical daytime peaks being about 135 percent of the nighttime. With lower demands for power, hydropower projects use fewer turbines and discharge less water. When more power is needed, hydropower projects use more turbines and discharge more water.

The number of turbines in use changes the most during the early morning and late evening hours. In most cases, there are more turbines in operation during the day than at night, which means that more water passes the dams during daytime. Since the Mid-Columbia River projects do not store large amounts of water, their ability to generate power depends to a large degree on upstream projects. Flow releases from Chief Joseph Dam (the large reservoir dam upstream of the Wells Dam) are timed to meet daytime load demands at the downstream dams throughout the day.

The operators of Columbia River hydropower projects coordinate their projects' operations to ensure the best use of the available water and the most efficient generation of power to meet demand. Upstream projects pick up more of the load in the morning, and downstream projects use the pulse of flow to generate electricity in the afternoon and evening. This coordination maximizes generation efficiency at the plants by minimizing reservoir drafting and maintaining efficient "operating heads" for the turbines.

As a general rule, the PUDs operate their turbines at the highest efficiency possible to maximize power generation and revenue for the facility.

Each turbine unit receives approximately the same amount of wear and tear through alternating turbine use. This process is relatively straightforward at Wells Dam, which has ten turbines of similar type and performance characteristics. Rock Island and Rocky Reach dams use several types of turbines, and the Chelan County PUD decides which turbines to use by considering how much water will be discharged and how efficiently each turbine will meet power demands. Turbine unit priorities may also reflect fish passage needs or other reasons not related to power generation.

When dams discharge water over their spillways rather than through their turbines, they lose the ability to use that water to generate power. Generally, dam operators prefer to minimize the amount of water they discharge over the spillway. Forced spill is necessary whenever the reservoir is at its normal maximum operating level, and when more water is entering the reservoir than the powerhouses can discharge. Because the dam operators along the Columbia River now coordinate their operations, the amount of forced spill has dropped significantly. When forced spill does occur, it typically is at night when energy demand is lowest, or during a period of high run-off.

At each of the mainstem PUD projects, some or all of the spill gates have dedicated automatic hoists to accommodate sudden storm or flood events in accordance with FERC requirements. The remaining spill gates are opened and closed using gantry cranes that serve more than one spill gate and perform other maintenance duties. It is generally preferred to conduct spill through hoist-equipped gates, so that the gantry cranes remain available for other uses. Ice and floating debris that accumulate in the forebay are usually removed with a crane. In extreme circumstances, floating material can be removed by passing it through sluice gates located at the reservoir surface level. Since the sluice gates at these projects are much smaller than the spill gates, they may also be used during forced spill events when the discharge volumes are small.

2.2.3 <u>HOW THE DAMS AFFECT MIGRATING FISH</u>

The dams on the Columbia River delay migrating fish, affecting migration speed and the timing of both juvenile and adult salmon and steelhead movements. Juveniles can be killed, injured or disoriented when they pass downstream through dams.

The major juvenile fish passage routes are:

- through a turbine;
- over a spillway or through a sluiceway;
- through a juvenile fish bypass system; or
- through ancillary dam facilities, such as the adult fishway facilities.

Direct or indirect effects to fish can result from any of these project passage routes. Direct effects are a consequence of physical injuries that may be incurred during passage, resulting in immediate or delayed mortality. Indirect effects result from debilitated, disoriented, or stunned fish being exposed to additional sources of mortality, such as predation (Chapman et al. 1994a).

Adults migrating upstream can also be impacted. Although under normal conditions it is likely that few adults are directly killed when they travel upstream past the dams, each dam can potentially delay fish at fishways (fishladders). Delays in fish passage may require fish to expend more energy to pass or increase their exposure to high concentrations of dissolved gases caused by spilling water at the dams.

The adult salmon and steelhead may also fall back through the dam, resulting in increased delays and potential injury. Additionally, a percentage of adults fail to enter project fishways and pass upstream. Even with the latest fish tagging technologies however, it is not possible to determine if the failure of fish to pass a project is due to specific problems with the fishladders. This is because some of the tagged fish detected at a project may actually be returning to downstream hatcheries or a natural spawning area.

Over the past several decades, many scientific studies have focused on the effects of the Columbia River system hydropower projects on anadromous fish. Some of the studies have focused specifically on the three Mid-Columbia River projects, while others have focused on the overall system, on other projects, or on particular effects. These studies have helped determine the ways hydropower projects impact fisheries, and they have shaped the actions needed to reduce impacts. However, the available studies do not always provide definitive assessments of the full range and magnitude of project impacts because different methods, timeframes, and locations were used.

2.2.3.1 Juvenile Passage

Juvenile salmon and steelhead pass the three Mid-Columbia River PUD dams through turbines or spillways, or through juvenile collection or bypass systems. Juveniles may be killed or harmed by any of these dam passage routes, but the highest levels of mortality typically occur when fish pass through turbines (Whitney et al. 1997). In an effort to increase survival, the project operators use bypass systems and spill during the juvenile migration period.

The three Mid-Columbia River PUD project operators intend that the majority of smolts pass the dams through bypasses or by spill, avoiding passage through turbines. This objective is measured through an assessment of “fish passage efficiency”, an important indicator of project effects. The proportion of fish passing through spillways and bypasses is essential information for estimating the overall survival of juvenile salmon and steelhead passing a project. However, project fish passage efficiency calculations may vary annually due to changes in fish species, environmental conditions, and powerhouse operations. Current project operations for enhancing juvenile passage are provided in Table 2-3.

Juvenile Passage Through Turbines

Juveniles passing through turbines can be killed or injured by mechanical, pressure or hydraulic-related factors. The turbine blades may strike fish, and fish can be injured passing through gaps between turbine components. Fish may be killed by pressure or hydraulic conditions, such as when fish pass through areas of cavitation (vacuums) or hydraulic shear, as well as pressure or velocity changes.

Indirect mortality occurs after fish have left the turbine. The principal cause of indirect mortality of juvenile fish is generally believed to be from predation by fish or birds. This most likely occurs in the immediate tailrace area as the juveniles recover from the disorientation and stress of turbine passage (Ledgerwood et al. 1990). Stress may also weaken the resistance to disease and cause subsequent delayed mortality (Ferguson 1994).

TABLE 2-3. SUMMARY OF EXISTING BYPASS SYSTEMS AND SPILL OPERATIONS AT WELLS, ROCKY REACH, AND ROCK ISLAND DAMS

PROJECT	BYPASS SYSTEM	PERIOD OF OPERATION
Bypass Systems/Operations		
Wells	Surface bypass (baffled spill gates with discharge through controlled spill of up to 8% of total river discharge)	24 hours/day; between at least April 10 and August 15, depending on the hydroacoustic index of juvenile fish migration timing
Rocky Reach	Turbine screens in two units; prototype surface bypass (discharge through conduit to tailrace)	Continue to evaluate and improve the efficiency of the bypass system, and provide spill as an interim measure (see below)
Rock Island	Passive gatewell orifice bypass (discharge through conduit to tailrace)	24 hours/day (spill is the primary bypass system used at Rock Island as described below)
Spill Operations		
Wells	See bypass operations (above)	See bypass operations (above)
Rocky Reach	15% of previous day's average flow in spring	30 days plus 6 additional days if necessary to encompass 90% of the Okanogan River sockeye run.
	10% of previous day's average flow in summer	Total of 34 days between June 15 and August 15
Rock Island	Spring and summer spill purchased by joint request of the Fisheries Agencies and Tribes from a Fisheries Conservation Account of $2.05 million (1986 dollars adjusted for inflation) at the market price of energy	The Fisheries Agencies and Tribes decide when and how much spill to purchase based on funds available in the Fisheries Conservation Account

There have been many turbine survival studies conducted with juvenile salmon and steelhead at the Snake, lower Columbia River and Mid-Columbia River dams. The resulting turbine mortality estimates have varied greatly, ranging from 2.3 to 19 percent (Whitney et al. 1997). When mortality has been estimated through the recovery of fish immediately after passing through turbines, the rates were typically less than 7 percent (average 5.5 percent). In studies with longer times between turbine passage and recovery, mortality levels averaged 10.9 percent (Whitney et al. 1997). This suggests that the higher mortality estimates include delayed mortality and the potential indirect mortality effects of predation on disoriented smolts, as well as direct mortality from turbine passage.

More recent evaluations conducted under turbine operational constraints that are presumed to provide the best fish passage conditions (i.e., operating within 1 percent of peak efficiency) indicate greater survival rates. The NMFS studies of turbine survival in the Snake River estimate survival at 92.0, 86.5, 92.7, and 93.4 percent in 1993, 1994, 1995, and 1997, respectively (Muir et al. in preparation). Thus, the average turbine passage survival estimate in these recent studies is 91.2 percent.

Wells Dam

Approximately 8 percent of the steelhead and spring-run chinook outmigrants pass through the turbines at the Wells Dam (Skalski 1993). Based on the information discussed above, the best current estimate of smolt survival for passage through turbines, that includes both the direct and indirect components of mortality, is 91.2 percent. The calculated estimate of juvenile dam passage survival is very similar to the results obtained during field evaluations conducted in 1998 and 1999 (Table 2-4).

TABLE 2-4. PASSAGE TIMES AND FALLBACK OF ADULT SALMON AND STEELHEAD, AS WELL AS JUVENILE PASSAGE AND SURVIVAL RATES, PASSING THREE MID-COLUMBIA RIVER DAMS[1]

	WELLS	ROCKY REACH	ROCK ISLAND
Adult Passage			
Median Project Passage Time (hours)			
Adult Spring-run Chinook	29-34	31-37	20-39
Steelhead	10	26	4
Summer Chinook	33-47	23-30	15
Fall Chinook	31-46		
Sockeye	5-22	36	17
Fallback (%)			
Adult Spring-run Chinook	4	0	0-3
Summer Chinook	>5	2-4	2-3
Steelhead	NA[2]	5	3
Sockeye	4	14	2-4
Juvenile Dam Passage			
Turbine Passage Rate (%)	8	39-73	60-80
Spillway Passage Rate (%)	NA	8-19	18-34
Bypass Passage Rate (%)	92	15-53	NA
Turbine Survival Estimate (%)	91.2	91.2	91.2
Spillway Survival Estimate (%)	NA	98	98
Bypass Survival Estimate (%)	>98	98	NA
Estimate of Total Juvenile Dam Passage Survival Rate (%) [3]	97	91-95	89-92
Measured Survival of Yearling Salmonids	94-100	86-96	89-96

1 Some studies used in this table have very low sample sizes but are the most recent estimates available.

2 NA = Not available.

3 These estimates do not include the cumulative effects associated with passage through the entire Columbia River hydropower system.

Sources: Adult Passage: Stuehrenberg et al. 1995; Swan et al. 1994; Alexander et al. 1998; English et al. 1998a, b
Juvenile Passage: Whitney et al. 1997; Skalski 1993; Bickford et al. 1999, 2000; Eppard et al. 1998; Stevenson et al. 2000.

Rocky Reach Dam

Two studies of direct mortality on juvenile passage through the Kaplan turbines at the Rocky Reach Dam found passage survival to be 94 percent in 1994 (RMC Environmental Services and Skalski 1994), and 95 and 96 percent in 1996 (Normandeau and Skalski 1996). Considering both direct and indirect mortality, the 91.2 percent survival rate estimated for Wells Dam is also assumed to represent overall turbine passage survival for all species at the Rocky Reach Dam, with peak turbine efficiency operations. The PUD has begun a multi-year process to install new turbines that are designed to reduce the gap between the blade and runner, which is one cause of direct mortality from turbines. The new turbines are also more efficient and will allow for greater flexibility in distributing powerhouse load among different turbines. These changes could improve the passage of juveniles through the tailrace, and reduce predation rates, by providing flow that is less likely to eddy along shoreline areas.

The survival estimates developed as a result of the PIT-tag evaluations conducted in 1998 and 1999 represent the best available information regarding both the direct and indirect effects of the Rocky Reach hydroelectric project on the survival of juvenile Upper Columbia River spring-run chinook salmon and steelhead. These studies indicate that juvenile spring-run chinook salmon survival ranges between approximately 72.8 percent and 118.7 percent ([weighted average = 85.9 percent], based on total project survival evaluations conducted on hatchery reared yearling fall chinook salmon in 1998 [Eppard et al. 1999]). Survival estimates for Upper Columbia River steelhead ranged from 87.9 percent to 111.9 percent ([weighted average = 95.9 percent] based on an analysis of the information collected by the Douglas County PUD on hatchery reared steelhead [Bickford et al. 2000]). The information also indicates that survival is higher through the spillway and bypass system than through the turbine units.

Rock Island Dam

Rock Island Dam has three different types of generating units. The first powerhouse contains a total of 10 vertical axis turbines that include four Nagler fixed blade units and six Kaplan-type adjustable blade units. The second powerhouse contains a total of eight horizontal axis bulb turbines. A study of Rock Island Dam has shown that the bulb and Kaplan turbines have a higher survival rate than the Nagler turbines. Fall chinook salmon passing through the Kaplan units had estimated direct survival rates of 96.1 and 95.7 percent, while fish passing the Nagler units showed 93.2 percent (Normandeau and Skalski 1997). As with Wells and Rock Island, the 91.2 percent survival rate that includes both direct and indirect causes of mortality is assumed to represent turbine passage survival for all species at the Rock Island Dam.

The survival estimates developed as a result of the PIT-tag evaluations conducted in 1998 and 1999 represent the best available information regarding both the direct and indirect effects of the Rock Island hydroelectric project on the survival of juvenile chinook salmon and steelhead. These studies indicate that juvenile Upper Columbia River spring-run chinook salmon survival is between approximately 62.4 percent and 135.6 percent ([weighted average = 89.3 percent]), based on total project survival evaluations conducted on hatchery reared yearling fall chinook salmon in 1998 [Eppard et al. 1999]), and juvenile Upper Columbia River steelhead survival is between approximately 84.6 percent and 110.8 percent ([weighted average = 95.8 percent], based on total project survival evaluations conducted on hatchery reared juvenile steelhead in 1999 [Stevenson et al. 2000]). Direct juvenile salmonid survival estimates calculated at the spillway and powerhouses, although not conclusive, are consistent with the trends identified in the PIT-tag survival evaluations.

Juvenile Passage Through Bypass Systems

Fish bypass systems are fairly complex systems that can include turbine intake screens, gatewell orifices, bypass flumes, dewatering screens, sampling facilities (including holding tanks), and bypass outfall conduits. These features vary by project, and all of them affect the survival rate of juvenile salmon and steelhead. Studies of bypass systems at the Snake and lower Columbia River projects suggest that mortality of wild steelhead and yearling chinook is generally less than 1 percent (Martinson et al. 1997; Spurgeon et al. 1997; summarized in NMFS Federal Columbia River Power System Supplemental Biological Opinion 1998). However, mortality rates vary by species and the size of fish due to factors such as propensity for scale loss and impingement on the screens (NMFS 1995). These figures do not include the level of mortality due to predation at the outfall, which requires further investigation (Ferguson 1994).

Bypass survival may also be indirectly affected by predation. Predation has been found to increase when outfall sites are poorly located or when they concentrate juvenile salmon and steelhead into a comparatively small volume of water. Juveniles also may be injured in the bypass system and then later succumb to predators.

When most Columbia River system dams were constructed, juvenile fish could pass only over the spillways or through turbines. As the number of mainstem dams on the Columbia and Snake rivers increased, the cumulative impacts on downstream migrating fish was recognized as a significant fisheries management problem. In the early 1950s, the U.S. Army Corps of Engineers started the Fish Passage Development and Evaluation Program to develop methods of safe juvenile fish passage at the mainstem dams (BPA et al. 1994a). Other entities have cooperated with this program and contributed additional research efforts, including USFWS, NMFS, State, tribal and Canadian resource agencies, and many public and private industrial concerns.

Juvenile dam passage survival is still considered to be the primary cause of salmon and steelhead mortality at hydroelectric projects, and is the primary area in which survival improvements are proposed to occur. The typical bypass system features can be divided into four groups: behavioral barriers, physical barriers, fish-diversion devices, and fish-collection devices.

Behavioral barriers attempt to move fish away from an area of concern by using measures that repel fish but do not physically block them. Examples are electrical screens, air bubbles, lights of various types, and sound barriers. These barriers allow water to pass freely, and avoid the problems of debris accumulation. They do not lower turbine efficiency, and they do not cause physical injuries to fish. However, there has been limited success with these measures under conditions experienced at large mainstem dams (Stone and Webster 1986).

Physical barriers and diversion devices are the most common bypass measures on the Columbia and Snake River dams. These two measures prevent fish from entering turbine intakes and provide an alternative passage route around the project. To be effective, the system must be designed to allow fish to locate and use the bypass entrance. Although the design parameters for physical barriers are based primarily on the swimming abilities and physical size of the fish, their effectiveness largely depends on fish behavior and conditions at the particular dam, which may vary considerably.

Nearly all physical barriers at mainstem Columbia basin dams involve a fish screen mechanism. As a result of years of investigative studies and evaluations of full-scale applications, NMFS has developed fish screen criteria to enhance the performance of these facilities (NMFS 1994). Fish swimming ability is a primary consideration in these criteria. Swimming ability can be estimated according to the species and size of fish, but swimming ability varies, according to factors such as the duration of swimming time required, the level of dissolved oxygen, water temperature, light conditions, the physical condition of the fish, and the migrational life stage.

Juvenile screening facilities have been added as a retrofit to turbine intakes at many dams. In many cases, it was not possible to fully screen turbine intakes because of constraints within the existing powerhouse structures, excessive water velocities, and conflicts with intended project operations. Partial screening systems are more common, and they reduce but do not eliminate turbine passage. The fish screens installed at typical projects intercept approximately the upper third of the turbine intake flow (DeHart 1993).

Fish screens for turbines do affect flow conditions and the changes may result in reduced turbine efficiency and greater pressure drops across the turbine runners. It may also move fish to lower portions of the water column. While fish screens should significantly reduce the number of fish passing through turbines, the mortality rate for fish through the turbines may be higher as a result (BPA et al. 1994b).

The fish screen barriers at the projects divert fish into gatewells located above the turbine intakes. The gatewells were originally designed for turbine operation and maintenance, but many have been modified for juvenile bypass. The most common approach is to install orifices that lead to a collection channel inside the dam. The collection channel runs the length of the powerhouse, then changes to either a pipeline or open flume that carries fish to the release site below the project.

The NMFS has developed bypass facility criteria with the objective of expediting fish passage with minimal injury (NMFS 1994). Criteria cover aspects of the bypass layout, entrance conditions, conduit design, and outfall conditions. While some of these criteria are based upon the swimming ability of the juvenile fish, others are concerned with juvenile behavioral responses to hydraulic conditions at the barrier and through the bypass facilities. Hydraulic conditions vary considerably from site to site and also change in response to seasonal flows. As a result, the design of bypass facilities is not a generic process and is very much dependent on the collection of site-specific hydraulic and biological data.

Additional research efforts are focusing on surface collector bypass systems owing largely to the success of the Wells Dam bypass system completed in 1989. Since juvenile anadromous fish tend to migrate in the upper portion of a reservoir, surface collector systems attempt to provide an opportunity for discovering a shallow passage route before juveniles dive to depths of 60 to 80 feet in the course of following flow towards turbine intakes and diversion screens. The Wells Dam system includes vertical baffle slots to create attraction flow into the spillway bypass, while other prototype systems are examining shallow skimmer weirs and orifices similar to the sluiceways at the Ice Harbor and The Dalles dams (BPA et al. 1994b).

Wells Dam

Hydroacoustic studies conducted from 1990 through 1992 at the Wells Dam estimated that 92 percent of the spring migrants, which include both steelhead and spring-run chinook salmon, were guided through the juvenile bypass system (Skalski 1993). These estimates have been supported by similar information collected during concurrent fyke net evaluations (Bickford 1997). A juvenile chinook balloon-tag study that was conducted in 1993 concluded that there was no measurable direct injury or mortality through the bypass system (RMC Environmental Services 1993). Although this study did not measure the effects of predation in the tailrace, bypassed fish are not concentrated at one location (as in the case of a bypass outfall), and the spillway flow only falls an average of 5 feet before becoming mixed back into the turbine discharge. These attributes may reduce the effects of predation in the tailrace. Therefore, the total direct and indirect mortality is likely similar to the 2 percent found at the lower Snake River project bypass systems (NMFS 1998).

The PUD operates the bypass system 24 hours a day throughout the time period it takes at least 95 percent of the juvenile spring and summer migrants to pass the Wells Dam. In 1999, the bypass was operated during 98.2 percent of the migration period (Wells Coordinating Committee, unpublished data). The Wells Coordinating Committee bypass team determines the operation dates for the Wells bypass system by utilizing monitoring information from hydroacoustic transducers installed in the forebay of the Wells Dam.

Rocky Reach Dam

A juvenile bypass system is currently being developed at Rocky Reach Dam. The system includes surface collection entrances and intake guidance screens in turbine units 1 and 2. Passage efficiency tests conducted in 1998 showed that approximately 41 percent of the radio tagged yearling chinook and 52 percent of the PIT-tagged steelhead passed the project via this route (English et al. 1998a) (see Table 2-4). The guidance efficiency levels for steelhead and chinook were an improvement to those achieved in 1997 with only one collector entrance in operation. In 1999, guidance efficiencies indicated that 32 percent of the chinook and 53 percent of the steelhead passed through the bypass system (Chelan County PUD 2000). In addition, sockeye and summer chinook passage rates were estimated at 15 and 39 percent, respectively in 1999 (Mosey et al. 1999). With improved hydraulic conditions at the intake screens, and with a properly sited bypass outfall, survival through the Rocky Reach bypass system may equal the 98 percent survival rate estimated for bypass systems at the lower Snake River dams.

Rock Island Dam

Powerhouse 2 is equipped with a passive bypass system (no intake screens for guidance) that allows fish to voluntarily enter turbine unit gatewells and exit via bypass orifices to a collection channel that leads to a fish sorting collection raceway. The annual passage of juvenile spring-run chinook salmon through this system has ranged from 8,500 to 33,500 from 1985 to 1996 (Fish Passage Center, Annual Reports 1985 – 1996). Although the percentage of the total population is small, this facility provides useful monitoring information about downstream juvenile migrants. Currently, Powerhouse 1 has no juvenile fish bypass system. As a result, spill is used as the primary non-turbine passage route at Rock Island Dam.

Juvenile Passage Through Spill

Fish passage spill occurs only during the juvenile migration season, generally from April through August. Spring spill (April through June) targets spring migrants (stream-type chinook, sockeye and steelhead), and summer spill (July through August) targets ocean-type chinook juveniles (Columbia Basin Fish and Wildlife Authority 1995). Spill passage reduces the number of juveniles that pass through the turbines, and is an easy and flexible system to implement. However, juveniles passing over the spillway face several risks. First, although rare at the spillway, the juveniles can sustain physical injuries, such as descaling, that may incapacitate or even kill them. Second, increasing spill may result in higher total dissolved gas levels downstream, which in turn, may cause gas bubble disease and reduce the survival rates of juvenile and adult salmonids. Juveniles that become injured or disoriented while passing over the spillway are also more susceptible to predation.

Based on past studies, juveniles that pass through spill most likely have mortality rates that range from zero to 2 percent (Anderson et al. 1993). However, local conditions, such as back eddies or other factors, may favor predators and cause higher rates of mortality (Whitney et al. 1997). Relative to other means of passage currently available, spillways are considered the most benign routes for juveniles to pass the Mid-Columbia River projects (Chapman et al. 1994a and b).

Wells Dam

Five of eleven spill bays at the Wells Dam have been modified to function as a juvenile bypass system. This system uses baffles to increase water velocities that attract surface oriented fish, which are then bypassed through the spillway (see previous section: Juvenile Passage Through Bypass Systems – Wells Dam).

Rocky Reach Dam

The Chelan County PUD provides up to 30 days of spill during the spring outmigrations, at a spill level of 15 percent of the daily average river flow over a 24-hour period, with an additional 6 days of spill if necessary to encompass 90 percent of the Okanogan River sockeye run. Chelan County PUD also provides 34 days of spill during the summer migration period (June 15 – August 15). The spill level during this period is set at 10 percent of the daily average river flow.

Studies at the dam have shown that between 8 and 18 percent of the spring migrating smolts pass through the spillway at the 15 percent spill level, resulting in spill effectiveness of between 0.5:1 and 1.2:1 (Steig et al. 1997; Chelan County PUD 2000). The estimated spill effectiveness for sockeye, coho and 0-age chinook salmon ranged between 0.2:1 and 1.5:1 in 1997 and 1998 (Chelan County PUD unpublished data).

Only one survival evaluation has been conducted at the Rocky Reach spillway. Juvenile coded-wire tagged coho salmon, released at one spill bay in 1980, resulted in an estimated 99 percent survival (Heinle and Olsen 1981).

Rock Island Dam

Spill is the preferred juvenile bypass measure at Rock Island Dam, but its use is limited due to total dissolved gas production.

In recent years, spill at Rock Island Dam was conducted through a Fisheries Conservation Fund, which allows the fishery regulatory agencies to request spill at their discretion up to a limit of $2,050,000 (1986 dollars) in lost energy revenue per year. Beginning in 2000 however, spill volumes between 21 and 41 kcfs are being provided, with the exact levels determined from the results of fish survival studies conducted in 2000 and 2001.

The PUD has also modified several existing spill gates to allow for more surface oriented spill and increased fish passage efficiency. During the 1998 spring migration, the Chelan County PUD spilled approximately 25 percent of the total daily river flow and passed about 27 percent of the yearling chinook and 26 percent of juvenile steelhead (Iverson and Birmingham 1998). The spill passage rates for other species were estimated at 20, 33, and 35 percent for sockeye, fall chinook and coho salmon in 1998. The total direct survival through the modified bays was estimated at 96.4 percent, versus 98.4 percent survival through a standard bay (Normandeau and Skalski 1998). However, the study also concluded that the reduced survival rate for the modified bay was the result of the shallow stilling basin at that location.

A subsequent study indicated that survival rates through modified bay with deeper stilling basins may be near 100 percent, although this has not been verified for all river conditions and spillway operations. A 98 percent average is the assumed direct survival rate for fish passing through spill at Rock Island Dam for all species, which is consistent with the estimates for other spillways in the Columbia River basin.

2.2.3.2 Adult Passage

Adult salmon and steelhead pass upstream through the Mid-Columbia River PUD dams via fishways that were typically installed during the original construction of the projects. The fishways typically consist of an entrance gallery and ladder, a diffuser system that provides additional water at the ladder entrances to attract upstream migrating adult fish, and a flow control section that maintains ladder flow over varying forebay elevations. Migrating adults can be delayed as they search for fishway entrances, although delays are also likely to occur at the entrances and in the collection galleries. The operation of adult fishladder traps (such as at Bonneville, Priest Rapids, and Wells dams) can result in additional delays. The delay and stress that adults experience during passage through multiple dams may reduce their spawning success. For example, those adults destined for the Methow River must pass through four Federal dams and five PUD dams before reaching their spawning grounds.

Observed total passage times for adult chinook and sockeye have ranged between 5 and 47 hours at Wells Dam, between 23 and 37 hours at Rocky Reach Dam, and between 15 and 39 hours at Rock Island Dam (see Table 2-4). Passage time for adult steelhead ranged between 4 and 26 hours at the three projects.

Under certain conditions, adult salmon and steelhead may also travel back downstream over a dam. Downstream passage can occur through fishladders, turbine units, over spillways or through juvenile bypass systems. Downstream passage or "fallback " can be either involuntary or voluntary. Voluntary fallback typically occurs when adults have unintentionally passed a specific tributary or hatchery and are moving back downstream. In addition, post-spawning steelhead (kelts) pass downstream to return to the ocean. Involuntary fallback occurs when adults are inadvertently entrained in flows through these passage routes, and must re-ascend the ladder before continuing their migrations to reach their natural spawning grounds or hatchery.

Studies in the lower Columbia and Snake rivers have found that direct adult mortality in the fishways is likely small under normal passage conditions. However, adults that fall back over the dam can suffer injury or mortality. Studies of mortality rates for fish that fallback through hydroelectric projects have ranged substantially, from lows of 3 and 5 percent at Bonneville Dam to nearly 25 percent at the Lower Granite Dam. Studies of the Mid-Columbia River projects have estimated fallback rates similar to those observed at other Columbia River basin projects, although these studies have not estimated mortality rates due to fallback (see Table 2-4). Fallback rates at the Mid-Columbia River dams (Wells, Rocky Reach, and Rock Island dams) have ranged between 0 and 21 percent for chinook salmon (Stuehrenberg et al. 1994; English et al. 1998a).

Although steelhead fallback rates (which are different from the downstream migration rates of post spawning steelhead [kelts]) are not available for Wells Dam, estimated fallback rates at Rock Island and Rocky Reach dams were 3 and 5 percent, respectively in 1998 (English et al. 1998a). Sockeye fallback rates in 1997 were 3.5 percent at Wells Dam (English et al. 1998b), 14 percent at Rocky Reach and 3.5 percent at Rock Island (English et al. 1998a).

Survival rates of adult salmon and steelhead passing through the Mid-Columbia River has not been estimated due to insufficient radio-telemetry data. However, the survival rates of upper Columbia River steelhead and spring-run chinook salmon through the lower Columbia River dams (from Bonneville to McNary dams) averaged 98.8 and 97.1 percent per project, respectively (NMFS 1998).

2.2.3.3 Fishladders and other Passage Protection Facilities

Each of the three dams has at least one fishladder for adult salmon and steelhead to pass upstream. Wells has two fishladders, Rocky Reach has one, and Rock Island has three. These ladders are typically along the banks of the river, although one of Rock Island's ladders is in the center of the dam. The ladders operate continuously, except for brief maintenance periods in winter. The ladders operate under criteria approved by relevant fisheries agencies.

All three dams have adult collection channels along the downstream length of the powerhouse. The channels use attraction flows to redirect fish toward the fishladders. All the dams have stations for counting adult fish passage.

Adult Reservoir Passage

Once adult fish migrate upstream past a dam successfully, they must swim through a reach of river that has changed substantially from its historic, free-flowing conditions. The reservoirs have reduced water velocity and increased holding area compared to natural river conditions. These changes could benefit migrating adults by decreasing travel times and adult energy consumption. However, the reservoirs can increase the potential for wandering or straying (lost orientation), that could lead to higher pre-spawning mortality or reduced spawning success (Volkman 1995). Higher water temperatures as a result of project reservoirs may also lead to higher prespawning mortality.

Decreased water velocity in reservoirs does not appear to slow upstream migration of adult salmon and steelhead. Prior to dam construction, chinook salmon migrated upstream in the Snake River at rates of 12 to 14 miles per day (Bjornn and Peery 1992). Steelhead migrated upstream in the unimpounded lower Columbia River at rates of 7 to 11 miles per day (Chapman et al. 1994a), and sockeye migrated at rates of 17 miles per day (Bjornn and Peery 1992) (Table 2-5). Migration rates for these species in the Rock Island and Rocky Reach reservoirs in 1997 ranged from 35 to 58 miles per day (English et al. 1998b). These data suggest that adult salmon and steelhead that successfully pass through Columbia River reservoirs have decreased travel times when compared to unimpounded systems.

Juvenile Reservoir Passage

Reservoir impoundments can create increased rearing area and provide overwintering habitat for juvenile anadromous salmonids. The slower water velocities can also affect the outmigration of anadromous salmonid juveniles by causing extended travel times and decreased survival rates. The use of the term "extended travel times" refers to slower rates of travel by outmigrating juvenile anadromous salmonids. Extended travel times due to passage through reservoirs also increases potential exposure of juvenile outmigrants to predatory fish and reduces migration survival (BPA 1994c).

2.2.3.4 Fish Production

Hatchery Facilities

The Chelan and Douglas County PUDs own six main hatchery facilities that produce fish as mitigation for project impacts (Table 2-6). Through agreements, five of these facilities are operated by the WDFW, and the sixth, the experimental Cassimer Bar Hatchery, is operated by the Colville Tribe. Each year, the PUDs interact frequently with the operators on issues such as mitigation, compliance, funding, facility maintenance, and special projects.

The Douglas County PUD's operation of the Wells Hatchery steelhead program has previously received a Section 10 permit (#1094, issued to WDFW on February 4, 1998) and NMFS has completed a biological opinion of the permit. The Methow Fish Hatchery spring-run chinook program is currently being considered in the review of Section 10 permit #1196 to WDFW, and NMFS is preparing a biological opinion.

The Chelan County PUD operations of the Turtle Rock and Chelan Falls hatchery facilities has also previously received a Section 10 permit (#1094 to WDFW). A spring-run chinook salmon program at the East Bank and Chiwawa facilities is currently being considered in a review of Section 10 permit #1196 to WDFW; NMFS is now preparing a biological opinion of that permit.

Reservoir and Tributary Production

Mainstem spawning and rearing habitat for anadromous salmonids in the Mid-Columbia River reach was inundated by the formation of the five PUD reservoirs between Priest Rapids Dam (river mile 397.1) and Chief Joseph Dam (river mile 545.1). The total surface area of the Columbia River between Priest Rapids and Chief Joseph dams doubled from 23,000 acres to 46,000 acres following inundation by the dams (Mullan et al. 1986). Since upstream passage facilities were not provided when the Chief Joseph Dam was constructed, this dam is the upstream extent of mainstem anadromous salmonid production.

Current natural anadromous salmonid spawning in the mainstem Mid-Columbia River is limited primarily to the free-flowing Hanford reach downstream of Priest Rapids Dam, and to the major tributaries including the Wenatchee, Chelan, Entiat, Methow and Okanogan River systems. Mainstem spawning also occurs in the upstream portions of the reservoirs in project tailrace areas where streambed hydraulics and substrate conditions allow (Carlson and Dell 1989, 1990, 1991, 1992; Dauble et al. 1994; Chapman et al. 1994b). Reservoir production concerns and issues are related to a reduction in fish habitat for spawning and juvenile rearing life-history stages, as well as aquatic productivity (Mullan 1986; Rondorf and Gray 1987). A more detailed description of existing spawning and rearing habitat is provided in Section 3.2.

2.2.3.5 Fish Transportation on the Mid-Columbia River

None of the Mid-Columbia River mainstem projects have navigation locks. Consequently, the transportation of fish potentially collected at the

TABLE 2-5. ADULT SALMONID MIGRATION RATES THROUGH IMPOUNDED AND UNIMPOUNDED WATERS OF THE LOWER COLUMBIA, MID-COLUMBIA AND SNAKE RIVERS (MILES/DAY)

	UNIMPOUNDED		IMPOUNDED		
	SNAKE RIVER	COLUMBIA RIVER	SNAKE RIVER	COLUMBIA RIVER	MID-COLUMBIA RIVER
Chinook	4.5-19		19-40	15	36
Steelhead	7	7-11	19	11	22
Sockeye	11	17		15	25

Source: Bjornn et al. 1995; Bjornn and Peery 1992; Chapman et al. 1994a, b; Stuehrenberg et al. 1995; Swan et al. 1994; English et al. 1998b.

TABLE 2-6. FISH PRODUCTION FACILITIES OWNED BY THREE MID-COLUMBIA RIVER PUDS

				YEAR	PRODUCTION FACILITIES					TOTAL	WATER SUPPLY (CFS)	
FACILITY / SATELLITE	OWNER	OPERATOR	COMPENSATION OBJECTIVE	CON-STRUCTED	ADULT HOLDING	INCUBATION	RACEWAYS	PONDS	NET PENS	VOLUME (CF)	SURFACE WATER	GROUND WATER
Cassimer Bar Hatchery	DCPUD	Colville Tr.	Assumed Wells project mortality	1992	yes	yes	yes	no	no	6,500	0	3
Osoyoos Lake Net Pens				1993	no	no	no	no	yes	48,000	N/A	
Chelan Hatchery	CCPUD/ WDFW	WDFW	Original Rocky Reach pool inundation and current project mortality	1965	yes	yes	yes	no	no	71,500	0	8
Eastbank Hatchery	CCPUD	WDFW	Original Rock Island pool inundation and current project mortality	1989	yes	yes	yes	yes	no		0	53
Carlton Pond				1989	no	no	no	yes	no	53,400	15	0
Chiwawa Pond				1989	no	no	no	yes	no	150,000	21	0
Dryden Pond				1989	no	no	no	no	no		30	0
Lake Wenatchee Net Pens				1989	yes	no	no	no	yes	59,200	N/A	0
Simikameen Pond				1989	no	no	no	yes	no	92,400	21	0
Methow Hatchery	DCPUD	WDFW	Assumed Wells project mortality	1992	yes	yes	yes	yes	no	62,500	18	10
Chewuch Pond				1992	yes	no	no	yes	no	25,000	6	0
Twisp Pond				1992	yes	no	no	yes	no	25,000	6	0
Methow Pond				1992	yes	no	no	yes	no	25,000	6	0
Rocky Reach Hatchery	CCPUD	WDFW	Original Rocky Reach pool inundation and current project mortality	1969	no	Yes	yes	no	No	29,000	0	6
Turtle Rock Pond				1974-1984	no	no	no	Yes	no	176,200	44	0
Wells Hatchery	DCPUD	WDFW	Original Wells pool inundation and assumed project mortality	1967	yes	yes	yes	Yes	no	991,636	171.8	19.8

CCPUD = Chelan County PUD DCPUD = Douglas County PUD three projects would have to rely on trucking. New systems would need to be developed to collect and transfer fish around each dam or into transportation facilities.

2.2.4 OTHER KNOWN HYDROPOWER EFFECTS

2.2.4.1 Water Quality

Total dissolved gas supersaturation is a condition that occurs in water when atmospheric gases are forced into solution at pressures that exceed the pressure of the over-lying atmosphere. Water containing more than 100 percent total dissolved gas is in a supersaturated condition. Water may become supersaturated through natural or dam-related processes that increase the amount of air dissolved in water. Supersaturated water in the Columbia River results from spilling water at the Mid-Columbia River projects and at upstream and downstream projects. Fish and other aquatic organisms that are exposed to excessive total dissolved gas supersaturation can develop gas bubble disease, that can be fatal to anadromous salmonids and other aquatic organisms.

The occurrence of total dissolved gas supersaturation in the Columbia River system is well documented and has been linked to mortalities and migration delays of salmon and steelhead (Beiningen and Ebel 1970; Army Corps of Engineers 1993; Gray and Haynes 1977). Total dissolved gas supersaturation in the Columbia and Snake rivers was identified in the 1960s and 1970s as a detriment to salmon and steelhead, and those concerns have reappeared as management agencies have re-instituted spill as a means of aiding fish passage around hydropower facilities (NMFS 1995).

Total dissolved gas supersaturation occurs in the Columbia River during periods of high run-off and spill at hydropower facilities, primarily because spill in deep tailrace pools can cause significant entrainment of gases. Water passed through turbines does not increase gas saturation to any appreciable degree (BPA et al. 1994a). The majority of the variation in total dissolved gas measured just downstream of spillways is explained by the amount of spill. The second-most influential variable is spillway plunge depth as indicated by tailrace elevation and stilling basin depth (BPA et al. 1994a). Total dissolved gas supersaturation varies substantially by season and by dam.

In addition to depth and pressure, gas supersaturation can be affected by water temperature. As water temperature increases, the amount of dissolved gas that can be held in solution decreases, resulting in greater relative percentages of dissolved gas levels. The consideration of temperature effects is important in the Columbia River where water temperatures vary daily and seasonally during salmon and steelhead migrations, and where temperature regimes have been altered by hydropower projects (Beiningen and Ebel 1970). More information on total dissolved gas and other water quality affects on fish is provided in Section 3.3.2.

2.2.4.2 Water Temperature

The thermal regime of the Mid-Columbia River is largely controlled by releases at Grand Coulee Dam and other upstream storage dams. Run of the river projects, such as the three PUD projects, may have limited capacity to affect water temperature because they have short retention times (only a few days) (BPA et al. 1994a). Thus, the Mid-Columbia River projects do not appear to significantly affect water temperatures.

High water temperature is a key water quality issue for the region, particularly during low flow conditions. High water temperature can pose a significant problem for salmon and steelhead. Warmer water can increase the incidence of disease; increase the energy demands of migrating fish; alter the timing of adult and juvenile migrations; change incubation, hatching and maturation times; and affect gas supersaturation (BPA et al. 1994a; Chapman et al. 1994b, 1995a; Dauble and Mueller 1993). In addition, given sufficient magnitude and duration of exposure, high water temperatures can be lethal to fish.

Water temperatures exceeding 19° C to 21° C have been shown to cause delays in migrating adult anadromous salmonids (Dauble and Mueller 1993). Within the Mid-Columbia River region, no delay of migration has been observed on the mainstem, but warm water flowing out of the Okanogan River has caused fish to remain in the mainstem until temperatures decreased (Alexander et al. 1998). Spawning fish have limited energy reserves, and any delay in migration may reduce those energy reserves to the point where the fish may not be able to spawn successfully (BPA et al. 1994a). High temperatures not only reduce energy reserves by extending the period of migration but also by increasing the metabolic rate of the fish.

Lethal water temperatures for juvenile spring-run chinook and sockeye salmon are 25.1° C and 24.4° C, respectively (Brett 1952). Adult anadromous salmonids are generally less tolerant of high water temperatures. When exposed to temperatures of 21° C or more, for greater than 7 days, 50 percent of adult salmon and steelhead populations experience mortality (Dauble and Mueller 1993). Nevertheless, mortality of fish may not be observed even when recorded temperatures exceed known lethal thresholds because fish may avoid high temperatures by ceasing migration or seeking out areas of cooler water (e.g., areas of in-channel groundwater upwelling).

Water temperatures at levels that may not directly kill anadromous salmonids may cause indirect stress-related mortality (Dauble and Mueller 1993). In addition, the rate of pre-spawning mortality can be increased by warm temperatures in combination with other stresses, such as disease through pathogenic agents and total dissolved gas (Dauble and Mueller 1993). Refer to Section 3.3.2.1 for more information on stream temperatures.

2.2.4.3 Predation

Construction of hydropower facilities on the Mid-Columbia River have created impoundments with habitat more conducive to predators compared to the pre-impounded free flowing river. Changes in physical habitat, water quality and downstream passage conditions have combined to increase the abundance of predators and the risk of juvenile outmigrant mortality due to predation (Mullan et al. 1986; Chapman et al. 1994b).

Dams present an obstacle to the downstream migration of juvenile anadromous salmonids, often causing them to concentrate in forebays before finding a route past the dam. Concentrations of juvenile anadromous salmonids provide a ready food supply for predators that congregate at such sites (Beamesderfer and Rieman 1991). Passage through turbines, spillways or bypass facilities may stun, disorient or injure some juvenile anadromous salmonids, making them less capable of escaping predators.

Sediment that formerly would have been suspended during high spring flows settles out in upstream impoundments, resulting in reduced turbidity in the Mid-Columbia River. Clearer water makes juvenile outmigrants potentially more visible and more susceptible to predation (Reid et al. 1988).

In addition to juvenile outmigrants being more susceptible to predators while migrating past the dams, the number of predators has increased to levels greater than pre-impoundment in the Mid-Columbia River reach. The deep, low velocity habitat created by impoundments is preferred by northern pikeminnow, the major native predator fish of juvenile anadromous salmonids. Two gamefish species, walleye *(Stizostedion vitreum)* and smallmouth bass *(Micropterus dolomieuri)*, were introduced into the Columbia River system in the 1940s to 1950s to provide sport fishing opportunities (Henderson and Foster 1956; Zook 1983). These piscivorous gamefish have become established in the Mid-Columbia River reservoirs, and prey on juvenile anadromous salmonid outmigrants.

Chelan and Douglas County PUDs have developed predator control programs at each of their projects to minimize the predation risks to juvenile salmon and steelhead. Each project has instituted programs to catch and remove predator fish from areas adjacent to the projects. These are typically hook-and-line fishing programs in the forebay and tailrace areas of the projects. Bird predation is also minimized by several activities funded by the PUDs. Gull deterrent wires have been installed across portions of the tailraces, to reduce gull access to these areas where juvenile fish are highly susceptible to predation. In addition, propane cannons and other pyrotechnic methods have been used to haze gulls further downstream of the projects. These protective measures are similar to programs used throughout the lower Columbia and Snake rivers, and are believed to be effective at reducing predation in the immediate project areas.

2.3 ALTERNATIVES CONSIDERED IN DETAIL

2.3.1 ALTERNATIVE 1 (NO ACTION)

Alternative 1 represents baseline conditions, which include the FERC licenses and amendments that govern current operations. These licenses cover all aspects of dam operation, as well as resource protection. Under Alternative 1, analyses in this EIS review how the licenses and the applicable amendments affect the environmental resources within the project area, including mitigation sites and hatcheries that may be outside of the immediate project boundary.

Provided below are the protection measures associated with Alternative 1 that are pertinent to anadromous fish for direct comparison to Alternatives 2 and 3, which pertain primarily to either two endangered fish species (Alternative 2) or five Plan species of anadromous fish (Alternative 3). The effect of these fish prescriptive measures on other environmental resources, in addition to fish, are described in Chapter 4 of this EIS.

2.3.1.1 Wells Hydroelectric Project

The original FERC license stipulated that two adult fishladders would be constructed at the Wells Project (adjacent to each embankment), as well as a "low bucket" spillway design that was approved by the State of Washington Department of Fisheries and Game (FERC 1962a). A subsequent amendment to the license stipulated a general requirement to provide mitigation for project construction, alteration, and operations, and to comply with reasonable requests to modify project structures and operations in the interest of fish and wildlife (FERC 1962b). Project structure revisions were approved in 1970 to comply with fishery agency requirements regarding fishladder design and operation (FERC 1970). The FERC (1982) amended the license to raise the forebay elevation by two feet.

In 1990, the Douglas County PUD, the Wells Project power purchasers, resource agencies, and Tribes entered into a long-term fisheries settlement agreement regarding the Wells Project (FERC 1991). The 1990 Wells Settlement Agreement established the requirements for the Douglas County PUD to fund, operate, maintain, and evaluate three anadromous fish related programs through at least March 1, 2004. These programs consist of: (1) juvenile downstream migrant fish passage measures, (2) adult passage measures, and (3) hatchery-based compensation measures for fish loss. These measures, in conjunction with existing hatchery compensation programs, were considered to fulfill Douglas County PUD's obligation to protect, mitigate and compensate for the effects of the Wells Project on anadromous fish. The agreement also stipulates evaluation programs for fishery measures and establishes procedures for coordination among the PUD, it's power purchasers, and the Joint Fishery Parties through the Wells Coordinating Committee. Coordinating Committee decisions are made on a consensus basis.

Juvenile Fish Passage

The juvenile fish passage program called for the installation and evaluation of a juvenile bypass system to route juvenile salmonids around turbine units. The established program uses controlled spill through modified spill bays to provide a non-turbine passage route through the project. The agreement includes specific operation, performance, and evaluation standards, as well as procedural guidelines for modifying the operational components of the system if necessary to meet the performance standards. The performance standards are set to provide fish passage efficiency (the percentage of fish bypassing the project through non-turbine routes over the total population of fish passing the project) of at least 80 percent during the juvenile spring migration period and at least 70 percent during the juvenile summer migration period.

Adult Fish Passage

The 1990 agreement called for evaluations of adult delay and mortality at the project beginning in 1991. If the evaluations identified delays and/or mortality, the agreement specified that operational modifications would be used to alleviate the problems. If those modifications could not correct the problems, the adult fishways would be modified.

Hatchery-Based Compensation

Under the Wells Settlement Agreement, the PUD agreed to fund a hatchery program to mitigate for fish passage losses at the Wells Dam. The agreement identifies specific production levels for the anadromous fish species affected by the project that are in addition to the existing mitigation program at the Wells Dam. The agreement also provides the ability to adjust these additional compensation levels based on actual juvenile and adult losses at the dam. However, production levels based on impacts of project inundation would not be altered. The agreement also establishes specific operational standards for the fish production facilities.

Measures Planned

The existing fish mitigation and compensation measures for the Wells Dam were developed through the Wells Settlement Agreement and subsequent negotiations within the Wells Coordinating Committee. A summary of measures expected to continue under Alternative 1 are:

1. Adult Passage:

    a. Continue operation and maintenance of the existing adult fishways.

    b. Investigate entrance and ladder modifications that may be necessary to improve ladder operation and minimize fish passage delay.

    c. Conduct modeling or other appropriate evaluations to determine the best actions for correcting any significant delay.

    d. Develop solutions and implement corrective actions where adult passage problems are identified. Specifically, improve the efficiency of the existing fishways by maximizing the number of adult migrants that enter the facilities.

    e. Continue operation of the juvenile surface bypass system from April through August to provide a fallback and downstream passage route for adult spring-run chinook salmon and steelhead through the dam.

2. Juvenile Passage

    a. Turbine Operations - Operate turbines at peak efficiency ratings, to the extent possible.

    b. Surface Bypass Operation - Operate at least one spillway bypass, 24 hours a day, throughout the juvenile downstream migration periods. The operation of the five bypass system bays (# 2,4,6,8 and 10) will be paired with associated turbine units. (see Table 2-3).

c. Predators - continue to refine and implement a northern pikeminnow removal program.

d. Gas Abatement - Control total dissolved gas levels under total river flows up to the 7-day 10-year peak flow event to 120 percent of saturation.

3. Hatchery Program

Continue to provide funding and hatchery capabilities to rear and release up to 49,200 pounds of spring-run chinook, 32,000 pounds of yearling summer chinook, 24,200 pounds of sub-yearling summer chinook, 8,000 pounds of sockeye, and 80,000 pounds of yearling steelhead, according to provisions in the settlement agreement. Under the settlement agreement, hatchery production for unavoidable losses could be reduced if survival studies indicate that fish passage mortality is less than the assumed 14 percent, which was the basis for the current mitigation level.

4. Monitoring and Evaluation

a. Juvenile Run Timing - Utilize hydroacoustic techniques to determine the timing of bypass system operations.

b. Survival - Develop and utilize the best techniques to estimate the survival of juvenile salmon and steelhead passing the project. Techniques may include the use of radio-telemetry or tag release and recapture methodologies.

c. Total Dissolved Gas Monitoring – Monitor total dissolved gas levels and temperature at fixed location monitors in the forebay and downstream of the dam. Provide biological monitoring to determine the incidence of gas bubble disease symptoms in adult salmonids.

d. Fish Counting - Provide adult fish counts on a 24-hour basis.

2.3.1.2 Rocky Reach Hydroelectric Project

The existing fishery protection measures undertaken by the Chelan County PUD for the Rocky Reach Dam are the result of mitigation and compensation requirements in the original project license and subsequent amendments (FERC 1953, 1957a, 1957b, and 1968), as well as an interim stipulation resulting from the Mid-Columbia Proceedings (Docket No. E-9569 [FERC 1987a]). The interim stipulation was an agreement between the Chelan County PUD and the Joint Fishery Parties with respect to juvenile and adult fish passage measures and hatchery compensation levels to mitigate for impacts resulting from project operations.

The interim stipulation identified compensation and operational requirements that would be in effect from July 1, 1987 through August 31, 1988. Subsequently, the stipulation was extended and revised several times (FERC 1989b, 1991b, and 1993c). The latest revision (Fourth Revised Interim Stipulation) was negotiated to include the period September 1, 1995 through December 31, 1997 (FERC 1996b). Although there is no current agreement for Rocky Reach, Chelan County PUD has continued to operate the project in coordination with the Mid-Columbia Coordinating Committee, as it has under the previous stipulations. Coordinating Committee decisions are made on a consensus basis.

The main goal of the Fourth Revised Interim Stipulation was to develop a safe (less than 2 percent mortality) juvenile bypass system capable of bypassing 80 percent of the juvenile salmon and steelhead over 90 percent of the migration period. Passage efficiency would then be used in developing a survival based performance standard for the Rocky Reach Project. This agreement led to the development of a prototype surface bypass system that was installed at Rocky Reach Dam in the fall of 1994. Since that time, the bypass system has been modified based on the results of hydraulic modeling and fish passage evaluations. During development of the surface bypass system, the Fourth Revised Interim Stipulation provided a protection plan for juvenile migrants through the use of spill.

Despite the expiration of the interim stipulation, Chelan County PUD has continued implementation of the associated programs through coordination with the Mid-Columbia Coordinating Committee. The fish protection measures consistent with the Fourth Revised Interim Stipulation include:

- Continue operation and maintenance of the adult fishways.
- Spill at a level equal to 15 percent of the daily average flow for a 30-day period, with up to six additional days to compensate for the Okanogan River sockeye run in the spring. In the summer, spill at a level equal to 10 percent of the daily average flow for a total of 34 days between June 15 and August15 (Table 2-3).
- Construct a permanent juvenile bypass facility capable of bypassing 80 percent of the juvenile migrating salmon and steelhead over 90 percent of the migration period.
- Continue to refine and implement a northern pikeminnow removal program, as well as continue to fund a hazing program to minimize the loss of juvenile fish to avian predators.
- Continue to provide funding and hatchery facilities adequate to rear and release up to 54,400 pounds of fall chinook and 30,000 pounds of steelhead annually.

2.3.1.3 Rock Island Hydroelectric Project

The original FERC license for the Rock Island Dam was issued in 1930 and construction was completed in 1933. In 1987, the Chelan County PUD, Puget Sound Energy (formerly Puget Sound Power & Light), resource agencies, and Tribes entered into a long-term fisheries settlement agreement for the Rock Island Hydroelectric Project (FERC 1987b). The provisions in the settlement agreement were included in the documentation for relicensing the project in 1989 (FERC 1989c). The Rock Island Settlement Agreement was amended in 1993 to replace the requirement to conduct an adult fish mortality study with the requirement to conduct an adult fish passage study (FERC 1993b).

The Rock Island Settlement Agreement established the requirements for the PUD to fund, operate, maintain and evaluate three anadromous fish related programs. These programs consist of: (1) juvenile fish passage measures, (2) adult fish passage measures, and (3) hatchery-based compensation measures. Coordinating Committee decisions are made on a consensus basis.

Juvenile Fish Passage

The Rock Island Settlement Agreement called for a bypass development program to study, design, develop, test, and install a mechanical juvenile fish bypass system at the project. The performance standards targeted for the bypass system included achieving at least 80 percent fish passage efficiency during the spring migration period and at least 70 percent fish passage efficiency during the summer migration period. Unfortunately, subsequent efforts to develop an adequate mechanical solution to the juvenile bypass issue were unsuccessful. Therefore, the PUD is currently evaluating modifications at the spillway to increase the rate of non-turbine passage at the project and utilizing a conservation account to provide spill.

As an alternative to juvenile bypass system development, the agreement established a Fisheries Conservation Account. This account (with an annual funding level of $2.05 million in 1986 dollars) could be used by the fishery agencies and Tribes to purchase spill as a means to increase the non-turbine passage of juvenile fish at the project.

Adult Fish Passage

The agreement called for modifications to the adult fishladders at Rock Island Dam to meet fishery agency operating standards, as well as a comprehensive hydraulic evaluation of the right bank ladder to ensure that the design flows were met.

Hatchery-Based Compensation

Under the Rock Island Settlement Agreement, the PUD agreed to construct, maintain, and fund a hatchery program to mitigate for fish passage losses at the Rock Island Dam. The agreement identifies the specific construction standards, production levels and evaluation procedures to be implemented. The agreement also provides the ability to adjust these additional compensation levels based on actual juvenile and adult losses at the project, although production levels intended to compensate for project inundation would not be altered. The agreement also establishes specific operational standards for the fish production facilities.

Fish protection measures developed in the Rock Island Settlement Agreement and included in Alternative 1 are:

1. Modify the existing adult fishladders so their operation meets current fishery agency operating criteria.

2. Utilize the conservation account to provide spill for spring and summer outmigrants up to $2.05 million (in 1986 dollars).

3. Continue to provide funding and hatchery capability to rear and release 250,000 pounds of salmon and 30,000 pounds of steelhead in a manner that is consistent with the maintenance of genetically distinct stocks.

4. Evaluate fish guidance efficiency using hydroacoustic and direct capture methods including assessments of injury and stress, and evaluate the hatchery programs, including sampling to determine hatchery versus natural components of steelhead returns, and an evaluation of hatchery production and its inter-relationship with natural production.

2.3.2 ALTERNATIVE 2 (SECTION 7 CONSULTATION)

In order for the utilities to be exempt from the take prohibitions imposed under Section 9 of the Endangered Species Act, they must consult with NMFS either directly via Section 10 (a)(1)(B) or indirectly through FERC under Section 7 (a)(2). Under Alternative 2, Section 7 (a)(2) consultations would produce a biological opinion following consultations between NMFS and FERC. As a result, the Wells, Rocky Reach and Rock Island hydroelectric projects would be operated according to existing FERC licenses and settlement agreements for unlisted species and according to additional measures potentially required as a result of this consultation process for listed species.

The Section 7 (a)(2) formal consultation process results in NMFS issuing a biological opinion on the effects of the proposed actions. In this case, the proposed actions are continuing operation of the Wells, Rocky Reach, and Rock Island hydroelectric projects. With the assistance of each utility, FERC would provide NMFS with the following information:

- a description of the action being considered;
- a description of the specific area that may be affected by the action;
- a description of any listed species or critical habitat that may be affected by the action;
- a description of the manner in which the action may affect any listed species or critical habitat, and

- an analysis of the cumulative effects; relevant reports and analyses prepared on the proposal; and, any other relevant studies or information on the action, the affected species, or critical habitat.

The NMFS would then evaluate this information and any other information available to determine whether the proposed action was likely to jeopardize the continued existence of listed species or was likely to result in the destruction or adverse modification of critical habitat (up to full mitigation for the project effects). Depending on this conclusion, NMFS would potentially require additional protection measures to ensure that listed species would continue to persist into the future with adequate potential for recovery. Under this process, FERC would then have the responsibility of ensuring that measures identified in the biological opinion were implemented at the PUD projects. The PUDs may either implement measures required by the biological opinion and FERC, or formally object to the mandatory requirements through litigation.

The Section 7 (a)(2) biological opinion is considered a living document that would be updated at any time given new information. Specific measures required in the initial biological opinion may be modified or new measures may be required as a result of this process. In addition, if other species were listed under the Endangered Species Act, additional consultation processes would occur. Although NMFS has not determined what, if any, additional measures would be required over the next 50 years to protect listed species, it is likely that the agency would require all measures necessary to ensure that the proposed actions were not likely to jeopardize the continued existence of endangered species or result in the destruction or adverse modification of critical habitat.

Measures may include corrective actions at the projects to improve survival through the action area and offsite mitigation measures if project specific measures were determined to be insufficient to recover listed species (offsite measures would likely be proposed before consideration of non power options).

Based on completed consultations at other mainstem Columbia and Snake River hydroelectric projects, protection measures would likely include a combination of the following:

- Measures that allow for increased upstream passage of adult fish through fishways and reservoirs and decreased fish injury and pre-spawning mortality (examples include hydraulic and structural fishway improvements. – specifically, ladder modifications and improved attraction flow to help move fish more quickly into the ladder systems and over the dams).

- Measures that provide for increased downstream passage of juvenile salmonids while minimizing fish injury (examples include increased spill programs [in association with operational and structural modifications to reduce total dissolved gas levels], expanded predator control programs, drawdown, and the development of improved fish bypass systems).

- If necessary to meet recovery standards, offsite compensation measures, such as tributary habitat improvements or artificial propagation may also be proposed (prior to requiring non power options).

These measures would be directed only at listed species and would possibly only occur during specific periods (seasonal). As a result, the benefits of these measures may not apply to unlisted species.

Initial survival standards for protection of the species have been developed as a result of preliminary survival information and life-history analyses. Evaluations conducted as part of the Quantitative Analytical Report (QAR) (NMFS 2000b) indicate a substantial risk of extinction for Mid-Columbia River spring-run chinook salmon and steelhead if recent ocean and freshwater survival rates continue. The Wenatchee River spring-run chinook and Methow River steelhead populations have the highest extinction risks based on these modeling assessments.

Expanding the baseline survival rates to reflect those observed from the 1960s through 1990 would lower the projected extinction risks to a degree, although these survival assumptions may be overly optimistic. Under all but the most optimistic scenarios, improvements in the average population growth rates are necessary to lower the extinction risks to acceptable levels (i.e., to levels below the extinction risks criteria established by the QAR workgroup).

Even assuming hatchery supplementation could increase population sizes to the interim recovery levels, these levels cannot be sustained naturally under recent total life-history survival rates. According to the QAR analyses, even the removal of the Mid-Columbia River dams would not be sufficient to recover these species if recent total life-history survival rates continue. Therefore, in addition to improved survival through the middle and lower Columbia River projects, and during the early life stages of the fish, improved environmental and climate conditions are necessary for the listed species to survive and recover.

Each measure implemented under Alternative 2 would continue until such time that NMFS determine that:

- other protective measures would increase survival,
- the proposed measures are determined to be ineffective or unsuccessful in increasing fish survival, or
- a species is delisted and it is determined that a previously approved protection measure is no longer warranted.

The decision to apply specific measures at each dam would depend on the benefit of the measures to Endangered Species Act-listed fish species, and not necessarily to all species passing through the projects. However, it is envisioned that each dam would have a combination of juvenile bypass options including a screened bypass and/or a surface bypass system, a spill program designed to maximize non-turbine passage, and improvements to the adult facilities intended to maximize project and pre-spawning survival.

If listed fish populations continue to decline, NMFS would likely find that additional protection measures are needed. Most of these additional measures would likely be in-water facility improvements although additional offsite measures may be recommended prior to requiring any decommissioning or drawdown options.

If required, natural river drawdown would have significant and substantial environmental effects to many of the existing natural, physical, and social resources. However, this type of operation would help to mimic the natural river conditions that existed prior to the construction of the hydroelectric facilities, and thereby minimize the impacts caused by the hydropower system.

Although not recommended by a Federal, State, or local agency at this time, the review of natural river drawdown was requested by organizations during public scoping for this EIS. Consequently, natural river drawdown at the three dams (Wells, Rocky Reach, and Rock Island) has been evaluated for Alternative 2 at a brief summarizing level to help understand and compare the overall differences between the alternatives. Although natural river drawdown is not an option under the existing FERC licenses, it could be evaluated during relicensing procedures. The current FERC licenses expire in 2006, 2012, and 2028 for the Rocky Reach, Wells, and Rock Island dams, respectively.

Drawdown to minimum operating pool (seasonal reservoir drawdown), which is an option under the current licenses, has not been shown to increase juvenile survival in the Mid-Columbia River. Therefore, it was not evaluated in this EIS.

2.3.2.1 Wells Hydroelectric Project

In 1990, the Douglas County PUD, the Wells project power purchasers, resource agencies, and Tribes entered into a long-term fisheries settlement agreement for the Wells Project. This agreement established the Douglas County PUD's obligation for the installation and operation of juvenile downstream migrant bypass facilities; hatchery compensation for fish losses, and adult fishway operation. These measures, in conjunction with existing hatchery compensation programs, were considered to fulfill the Douglas County PUD's obligation to protect, mitigate and compensate for the effects of the Wells project on the anadromous fish resource.

Initial compensation was established at 14 percent based on the estimated survival of juvenile salmonids passing through the original turbine units. Measures undertaken by the Douglas County PUD that would likely continue to be incorporated in a long-term fish recovery plan include those proposed in the existing biological assessments for the project (Douglas County PUD 1998, 1999a) and resulting interim biological opinion (NMFS 2000b). Additional measures may also be required by NMFS, including any actions necessary to increase the survival of listed species.

Measures currently anticipated to be part of the protection program required by NMFS include:

1. Adult Passage – In addition to the measures described under Alternative 1 for Wells Dam:

    a. Conduct evaluations on spawning success and fecundity as it relates to passage through a multiple dam system.

    b. Operate the surface bypass system during the upstream adult steelhead and spring-run chinook migration periods and during the downstream kelt passage period to maximize the survival of fallbacks and downstream migrating adults.

2. Juvenile Passage – Operating within 1 percent of peak turbine efficiency at all times during the juvenile and adult listed species passage periods would be required, with appropriate reporting and monitoring requirements to ensure compliance.

3. Hatchery Program – The same amount of chinook, sockeye, and steelhead would be produced as described under Alternative 1. In addition, Douglas County PUD would fund the changes in hatchery procedures and evaluations needed to make the hatchery compensation program consistent with recovery of spring-run chinook salmon and steelhead populations.

4. Monitoring and Evaluation – Measures are the same as described under Alternative 1 for juvenile run timing, survival, total dissolved gas monitoring, and fish counting. The following additional measures are expected to be implemented:

    a. Cumulative Effects - In conjunction with NMFS, develop methodologies and conduct evaluations to assess the effects of passage through multiple dam systems on the fecundity, spawning success, and survival of adult spring-run chinook salmon and steelhead.

    b. Evaluate adult fishladder passage standards, as they relate to spring-run chinook salmon and steelhead, and modify facilities as needed.

As stated, NMFS would require any additional measures necessary to recover listed species based on information obtained from monitoring and evaluation of project survival and on the species recovery status.

2.3.2.2 Rocky Reach Hydroelectric Project

Long-term protection measures for the Rocky Reach Dam would likely be similar to those described in biological assessments submitted to

NMFS in 1998 and 1999 (Chelan County PUD 1998a, 1999a) as well as any additional measures necessary to maximize survival and recovery of listed species, based on additional information available to NMFS and as a result of continued monitoring and evaluation.

Measures currently anticipated to be part of the protection program required by NMFS include:

1. Adult Passage – In addition to continuing operation of the fishladders:

    a. Enhance the fishway entrance attraction conditions through planned operation of spill gates and turbines.

    b. Investigate ladder modifications to improve operations within specified standards, and minimize fish passage delay.

    c. Provide safe downstream passage facilities for adult fallbacks and kelts (e.g., bypass system operations, spill, etc.).

    d. Conduct modeling or other appropriate evaluations to determine the best actions for correcting passage problems, and implement measures as necessary.

    e. Conduct evaluations on spawning success and fecundity as it relates to passage through a multiple dam system.

2. Juvenile Passage – Measures in addition to those described in Alternative 1 would include:

    a. Construct a permanent juvenile bypass system to NMFS criteria that maximizes the non-turbine passage of listed species.

    b. Operate turbine units within 1 percent of peak turbine efficiency at all times during the juvenile and adult listed species passage periods, with appropriate reporting and monitoring to ensure compliance.

    c. Increase spill as necessary to prevent the extinction of listed species.

    d. Implement measures to ensure that total dissolved gas levels are maintained below 120 percent of saturation under total river flows up to the 7-day 10-year peak flow event.

    e. Implement effective predator control measures.

3. Hatchery Program – The same amount of chinook and steelhead would be produced as described under Alternative 1. In addition, fund the changes in hatchery procedures and evaluations needed to make the hatchery compensation program consistent with recovery of spring-run chinook salmon and steelhead populations.

4. Monitoring and Evaluation – In addition to those measures described under Alternative 1:

    a. Cumulative Effects – In conjunction with NMFS, develop methodologies and conduct evaluations to assess the effects of passage through multiple dam systems on the fecundity, spawning success, and survival of adult salmonids.

    b. Survival - Utilize the best techniques to estimate the survival of spring-run chinook salmon and steelhead through the project. Techniques would likely include the use of PIT-tags for juveniles and radio-telemetry methodologies for adults.

    c. Total Dissolved Gas Monitoring - Conduct physical monitoring of total dissolved gas levels and temperature within the project area. Conduct biological monitoring to determine the incidence of gas bubble disease symptoms in juvenile steelhead and spring-run chinook.

    d. Fish Counting - Provide adult fish counts on a 24-hour basis.

e. Evaluate adult fish passage efficiencies through radio telemetry studies.

As stated, NMFS would require any additional measures necessary to prevent the extinction of listed species based on information obtained from monitoring and evaluation requirements imposed under Alternative 2 and on the species recovery status.

2.3.2.3 Rock Island Hydroelectric Project

Long-term protection measures for the Rock Island Dam would likely be similar to those described in biological assessments submitted to NMFS in 1998 and 1999 (Chelan County PUD 1998b, 1999c), as well as any additional measures necessary to maximize the survival and recovery of listed species, based on additional information available to NMFS and as a result of continued monitoring and evaluation.

Measures currently anticipated to be a part of the protection program required by NMFS include:

1. Adult Passage –In addition to continuing operation of the fishladders:

    a. Provide safe downstream passage facilities for adult fallbacks and kelts (e.g., bypass system operations, spill, etc.).

    b. Evaluate passage facilities through hydraulic evaluations and adult passage studies and correct problems when identified.

    c. Investigate ladder modifications to improve operations within specified standards, and minimize fish passage delay.

    d. Conduct evaluations on spawning success and fecundity as it relates to passage through a multiple dam system.

2. Juvenile Passage – Measures in addition to those described under Alternative 1 would likely include:

    a. Construct a permanent juvenile bypass system to NMFS criteria that maximizes the non-turbine passage of listed species.

    b. Operate turbine units within 1 percent of peak turbine efficiency at all times during the juvenile and adult listed species passage periods, with appropriate reporting and monitoring to ensure compliance.

    c. Increase spill as necessary to prevent the extinction of listed species.

    d. Implement measures to ensure that total dissolved gas levels are maintained below 120 percent of saturation under total river flows up to the 7-day 10-year peak flow event.

    e. Implement effective predator control measures.

3. Hatchery Program – The same amount of salmon and steelhead would be produced as described under Alternative 1. In addition, fund the changes in hatchery procedures and evaluations needed to make the hatchery compensation program consistent with recovery of spring-run chinook salmon and steelhead populations.

4. Monitoring and Evaluation – In addition to those measures described under Alternative 1:

    a. Cumulative Effects - In conjunction with NMFS, develop methodologies and conduct evaluations to assess the effects of passage through multiple dam systems on the fecundity, spawning success and survival of adult salmonids.

    b. Survival - Utilize the best techniques to estimate the survival of spring-run chinook salmon and steelhead through the project. Techniques would likely include the use of PIT-tags for juveniles and radio-telemetry methodologies for adults.

c. Total Dissolved Gas Monitoring - Provide physical monitoring of total dissolved gas levels and temperature within the project area. Provide biological monitoring to determine the incidence of gas bubble disease symptoms in juvenile steelhead and spring-run chinook.

d. Fish Counting - Provide adult fish counts on a 24-hour basis.

e. Evaluate adult fish passage efficiencies through radio-telemetry studies.

5. As stated, NMFS would require any additional measures necessary to recover listed species based on information obtained from monitoring and evaluation requirements imposed under Alternative 2 and on the species recovery status.

2.3.3 ALTERNATIVE 3 (PROPOSED ACTION – PROJECT HCPS)

The applicants' proposed action consists of implementing the three HCPs for the operation of the Wells, Rocky Reach, and Rock Island hydroelectric projects. The HCPs were developed to conserve and protect listed *and* non-listed anadromous fish species over the long term, and to support ongoing compliance with the Endangered Species Act, while allowing continued operation of the three projects. The HCPs would be comprehensive long-term settlement agreements under the Endangered Species Act, the Federal Power Act, the Fish and Wildlife Conservation Act, the Northwest Power Planning and Coordination Act, and Title 77 RCW.

This EIS reviews only NMFS' decision to issue the incidental take permits required by the HCPs. NMFS is not required to prepare an EIS for its decision to sign the settlement agreement portions of the HCPs (the EIS required for implementing measures in the HCPs would be undertaken by FERC with a separate Section 7 consultation with NMFS regarding the effects of the settlement agreements on listed species).

The requirements of Section 10 of the Endangered Species Act provide the guidelines for HCP preparation. The information within each of the HCPs includes the following:

- the environmental setting in the project vicinity,
- structural and operational features of the project,
- existing operations related to anadromous salmonids,
- existing mitigation and monitoring measures, and their effectiveness,
- unresolved issues related to anadromous salmonids (note: an adaptive management plan to address changing circumstances and unknown future events addresses this issue in the proposed HCPs),
- proposed mitigation and enhancement measures to address unresolved and unknown future issues (note: an adaptive management plan to address changing circumstances and unknown future events addresses this issue in the proposed HCPs),
- proposed monitoring,
- costs and funding, and
- alternatives to the proposed measures.

2.3.3.1 HCP Species

In addition to the Endangered Species Act-listed species, the HCPs provide additional protection to the other anadromous fish species that occur in the Mid-Columbia River (Plan species).

The Plan species addressed in the HCPs are spring-run chinook salmon, summer/fall chinook salmon, sockeye salmon, coho salmon, and steelhead inhabiting the Mid-Columbia River basin. In addition, the HCPs also identify Permit species (species covered under the incidental take permit application). The Permit species include all the

Plan species, except coho salmon. The native coho salmon populations are considered extirpated from the Mid-Columbia River region and are therefore not subject to Endangered Species Act protection or an incidental take permit.

2.3.3.2 HCP Baseline Conditions

The HCPs do not address impacts resulting from original project construction or mitigation for past damages (Regulations Preambles 1986-1990, FERC Stats. and Regs, paragraph 30,869 at 31,613 (1989), 55 Fed. Reg. 4:8-9 (Jan. 2, 1990). Mitigation measures for these impacts have already been implemented as part of the existing licenses. Prior activities are not considered an action subject to additional mitigation beyond license requirements unless they are considered to cause a continuing "take" of a listed species as defined under the Endangered Species Act.

Existing hatchery production levels are initially assumed to provide adequate compensation for original inundation by the projects. Therefore, the baseline is considered to be the existing conditions.

These baseline conditions also form the basis for determining what effect continuation of the existing conditions would have on listed species. The baseline conditions that existed as of January, 1997, would be used to determine if progress were being made to increase the survival of the Plan species through the implementation of the HCPs.

2.3.3.3 HCP Term

The terms of the three HCPs and any incidental take permits are to be 50 years from the date the HCPs are executed. In the event any PUD project is not relicensed to that PUD, the component HCP for that project would terminate.

The HCPs also have termination provisions if the performance standards are not achieved. An HCP could be less than 50 years under the following circumstances:

- FERC issues a non-power license for the project;
- FERC orders removal or drawdown of the project;
- 15 years after March 1, 1999 (20 years for Douglas County PUD), if No Net Impact has not been achieved or maintained, or if No Net Impact has been achieved and maintained but Plan Species are not rebuilding and the Project is a significant factor in the failure to rebuild;
- if a party fails to comply with the terms of the HCP;
- if the obligations imposed by the HCP are impossible to achieve;
- if NMFS revokes the incidental take permit; or
- if a regulatory entity takes action that materially alters or is contrary to one or more provisions of the HCP.

Any party to the HCP (except the PUDs) may elect to withdraw from the agreement at any time, based on the non-compliance provisions of the HCP agreements. However, NMFS and USFWS will not exercise their right to withdraw from the HCP if the PUDs have complied with all aspects of the agreement but have not met the survival standards. If mutual agreement is reached between the PUDs and the two Federal agencies, the Services (NMFS and USFWS) can seek natural river drawdown, dam removal, and/or non-power operations without withdrawing from the agreement or suspending or revoking the Incidental Take Permit.

During the 50-year HCP term, all three projects would undergo a relicensing process with FERC. It is the intention of the PUDs that mitigation measures agreed to as part of the HCP be consistent with, and where possible form the basis of subsequent FERC license articles developed to address impacts on anadromous salmonids. Therefore, unless the parties to the HCPs withdraw from the HCP agreements (following the prescribed withdrawal procedures), they would be supportive of a new license, and the HCPs would constitute the terms, conditions, and recommendations for Plan species under Section 10 (a), Section 10 (j), and Section 18 Fishway Prescriptions in the new license.

The HCP agreements stipulate a dispute resolution procedure that would apply to all disputes over the implementation and compliance of the agreements. While it is the intention of the parties to utilize dispute resolution whenever possible, NMFS specifically reserved the right to use whatever enforcement powers and remedies are available under the Endangered Species Act by law or regulation, without first resorting to this resolution process. In the event that NMFS elects to pursue an enforcement action for a violation under the Endangered Species Act, the PUDs shall be given notice and an opportunity for a hearing with respect to such violation. It should be noted that measures consistent with the HCP agreements and protocols, by definition could not violate the Endangered Species Act.

2.3.3.4 HCP Mitigation Objectives

All measures proposed in the HCPs are intended to minimize and mitigate impacts to the Plan species, to the "maximum extent practicable" as required by the Endangered Species Act. Measures are developed by considering what is necessary from a biological standpoint to mitigate impacts of operating the hydroelectric facilities on the Plan species, and what the PUDs determine is economically feasible in terms of the continued operation of PUD facilities.

The HCPs would mitigate impacts from dam operations in areas directly affected by those operations (project areas). The project areas extend from approximately 1,000 feet downstream of each dam (tailrace) to about 1,000 feet downstream of next dam upstream (reservoir). The PUDs would also provide funding and other assistance for off-site measures intended to increase the natural productivity of Plan species, to offset losses not directly mitigated within the project areas. These off-site measures might also benefit other aquatic species, which might occupy the same habitat.

2.3.3.5 HCP Performance Standards

The HCPs have specific performance standards that relate to the survival of each Plan. The overall performance standard is to achieve No Net Impact to the Plan species through each dam, and is referred to as "100 percent No Net Impact." This term takes into account the fact that 100 percent survival cannot be achieved at the projects alone, but also must include off-site measures to increase salmonid productivity (e.g., hatchery supplementation programs and tributary habitat improvements).

The 100 percent no net impact standard consists of two components:

1. 91 percent project survival rate achieved within the geographic area of the projects by fish passage improvement measures, including an independent standard of 95 percent juvenile dam passage survival.

2. 9 percent compensation for unavoidable project mortality provided through hatchery and tributary programs, with 7 percent compensation provided through hatchery programs and 2 percent compensation provided through tributary habitat improvement programs.

Tributary habitat improvement programs would involve the protection and restoration of salmonid habitat within the Columbia River watershed (from the Chief Joseph tailrace to the Rock Island tailrace), and the Okanogan, Methow, Entiat, and Wenatchee river basins.

The PUDs would use "best efforts" to evaluate, improve, maintain, and operate adult and juvenile fish passage systems to meet the performance standards. Best efforts are referred to as "tools" which are any action, structure, facility or program (on-site only) that are intended to improve the survival of Plan species migrating through the project areas.

Monitoring of both on-site and hatchery mitigation measures would be conducted, and mitigation measures would be modified, as necessary, to achieve or maintain 100 percent no net impact, provided that no more than 7 percent of unavoidable project mortality would be provided through hatchery compensation without concurrence of the Joint Fisheries Parties. However, due to the difficulty and uncertainties associated with monitoring the effects of tributary habitat improvements, this component will compensate for 2 percent of the unavoidable project mortality and will not be monitored for survival contribution or modified during the 50-year term of the HCPs.

The no net impact standard represents input from NMFS, USFWS, and WDFW biologists, and was developed in coordination with tribal and PUD biologists. In addition, it is consistent with the performance standards included in Section VIII.A.15 of the 1995 Federal Columbia River Power System biological opinion for the lower Snake and Columbia River projects (NMFS 1995). In-river survival evaluations would determine if the survival standards were being met.

The no net impact and survival standards are designed to have several layers of requirements to provide the most flexibility in achieving the goal of recovering and stabilizing the anadromous fish runs in the Mid-Columbia River. For example, while the 95 percent juvenile dam passage survival standard is applicable to 95 percent of the run period of each species, the 91 percent project survival standard is a requirement of the entire run. In addition, the 91 percent survival standard also includes reservoir survival and the dam passage survival of returning adults.

Although there is limited survival information available for all the Plan species at each of the three dams, recent improvements in fish tagging technology (e.g., passive integrated transponder [PIT]-tags, miniature radio, sonic and balloon tags) will provide much more detailed and accurate future assessments. These tag improvements and other assessment techniques should provide quantifiable survival estimates through the entire project areas, as well as individual passage routes.

The overall survival rate estimates would determine if the survival standards are being met. However, the off-site compensation activities (e.g., hatchery production and tributary improvement activities) are based on specific levels that are assumed to be adequate. These compensation levels would not be increased.

The HCPs set an initial 5-year period for the PUDs to meet the 95 percent juvenile dam passage survival standard followed by up to 3 years of evaluation. If the survival standards are not met, the HCP Coordinating Committees (which includes NMFS) would then identify additional tools to implement, prior to the next migration period, to achieve 95 percent juvenile dam passage survival and 91 percent project survival.

2.3.3.6 HCP Phases

The HCPs would be executed in three phases. Phase I would occur during the initial 5-year period (1998 – 2002). During Phase I, the PUDs should reach or demonstrate steady progress toward reaching and maintaining HCP project survival standards through implementation of protection measures. During Phase I, the PUDs would have the ultimate decision on the implementation of tools to achieve the 95 percent juvenile dam passage survival standard. The Coordinating Committees would evaluate the success of the protection measures to determine if the measures are likely to meet the survival standards. If the committees conclude that the standards will not be met, parallel actions (e.g., additional spill) can be required.

Note that the PUDs are currently working towards meeting the survival standards. If the HCPs are implemented, Phase I begins April 1, 1998 with the baseline conditions represented as 1997. This baseline would be used to assess steady progress toward achieving the survival standards over the remaining period, through 2003. Adherence to steady progress however, would not be monitored until the HCPs were actually implemented.

At the end of Phase I, the Coordinating Committees would conclude whether passage survival meets the HCP requirements. Where survival standards are met for specific dams or species, the PUDs would proceed to Phase III. For those dams and species where survival standards are not met, the PUDs would proceed to Phase II.

Phase II includes additional tools that are needed to meet the passage survival standards. The Coordinating Committees would identify the additional tools or studies that are to be implemented for the projects to meet the survival standards, using the following criteria:

1. likelihood of biological success;

2. time required to implement; and

3. cost-effectiveness of solutions, but only where two or more alternatives are comparable in their biological effectiveness.

For Phase III, where the survival standards are met for specific species, the Coordinating Committees would periodically review project survival to ensure that it is maintained according to the HCP requirements. If project survival falls below the standards during Phase III, Phase II would be reinitiated for those species.

2.3.3.7 HCP Committees

The three HCPs would be implemented through four committees:

- two Coordinating Committees,
- one Tributary Committee, and
- one Hatchery Committee.

All of the committees are represented by one member of each signatory party. Douglas County and Chelan County PUDs would have separate Coordinating Committees for the Wells and Rocky Reach/Rock Island projects, respectively. There would be one Tributary Committee and one Hatchery Committee that cover all three HCPs.

The Coordinating Committees would oversee HCP monitoring programs, and periodically evaluate the protection measures to assess actual project survival and unavoidable project mortality provided that no more than 9 percent unavoidable project mortality shall be made up through hatchery and tributary compensation. If any project, for any species, cannot obtain the 91 percent project survival (including the 95 percent juvenile dam passage survival standard), then the PUDs shall consult with the signatory parties through the Coordinating Committees to jointly seek a solution.

The Tributary Committee is charged with the task of selecting projects and approving project budgets from the Plan Species Account for purposes of implementing the Tributary Conservation Plan based on the 2 percent compensation standard.

The Hatchery Committee is responsible for evaluating the hatchery program and ensuring that adequate compensation is being maintained based on the 7 percent compensation standard.

2.3.3.8 HCP Conservation Plan and Compensation Measures

The measures described below are currently considered to be the tools that Chelan and Douglas County PUDs would use to meet the 91 percent project survival and the 95 percent juvenile dam passage survival standards.

Wells Dam

Outside of the existing mitigation measures negotiated during the 1990 long-term fisheries settlement agreement for the Wells project (FERC 1991), no new structural modifications have been identified to date. The existing juvenile fish bypass system at Wells Dam is estimated to have an overall survival rate of about 98 percent. However, Douglas County PUD would continue to work with fishery agencies and Tribes to optimize passage conditions by refining operating standards for adult fishladders and developing minor structural changes to improve ladder efficiencies. The Douglas County PUD would use its best efforts to undertake any feasible passage project measure that is biologically effective and cost efficient. A 3-year project survival study to assess reservoir and project passage survival would be funded, as well as additional studies of predator behavior and population dynamics to reduce the number of predators in the project area.

Rocky Reach Dam

The Chelan County PUD would be undertaking various interim, prototype, and permanent measures at the Rocky Reach project in an effort to achieve a 95 percent juvenile dam passage survival rate for juvenile salmonids migrating through the Rocky Reach forebay, dam, and tailrace. These measures would include interim spill; bypass diversion screen operations; surface collection system development, testing and installation; turbine replacement; and predator control. The appropriate mix of measures would vary as the surface collection system is improved and its efficiency tested and quantified.

Survival data would determine the number, type, and magnitude of the various protective measures needed to achieve the 95 percent juvenile dam passage survival standard and an adult passage rate through the project that would meet the overall 91 percent project survival standard that includes both juveniles and adults. Actions would also be taken to improve survival and assure timely passage of adult salmonids through the project. Measures in the Rocky Reach HCP include:

- Design, model, prototype test, and install a turbine bypass system consisting of a surface collection system with or without secondary collection from a limited number of turbine intake screens.
- Modify replacement turbine runners to improve survival of juvenile salmonids as much as possible, given manufacturing, technical, and installation schedule limitations.
- Continue implementing a spill program that provides spill levels of 15 percent of the daily average flow for a 30-day period during the spring juvenile migration. In addition, provide up to 6 additional days of 15 percent spill to encompass 90 percent of the Okanogan sockeye run. During the summer, spill 10 percent of the daily average flow for a total of 34 days between June 15 and August 15. Spill may be adjusted or discontinued based on the relative success of other protection measures.
- Immediately initiate evaluations of spill efficiency and total dissolved gas abatement options. To the extent that spill or other spillway-type passage measures are employed at the project to achieve 95 percent juvenile fish dam passage survival and no net impact, Chelan County PUD would coordinate its use with upstream and downstream projects to address total dissolved gas levels.
- Maintain effective predator control measures.
- Perform the necessary studies to properly monitor and evaluate on-site mitigation measures.

Rock Island Dam

Similar to the Rocky Reach Project, the Chelan County PUD would undertake various interim, prototype, and permanent measures at Rock Island Dam in an effort to achieve the 95 percent dam passage survival standard for juvenile salmonids migrating through the Rock Island forebay, dam, and tailrace. These measures could include a juvenile bypass system, modified spill gates for surface spill, continued or expanded measures for predator control, and possible improvements to turbines. Survival data obtained at each step in the process would determine the number, type, and magnitude of the various protective measures needed to achieve the 95 percent juvenile dam passage survival standard. Actions would also be taken to improve survival and assure timely passage of adult salmonids through the project to meet the 91 percent project survival standard. The measures could include:

- designing, modeling, prototype testing, and installing spill gate modifications to provide surface spill to increase fish passage efficiency;
- testing and evaluating various spill configurations;
- continue implementing the existing spill program;
- designing, modeling, prototype testing, and installing a turbine bypass system consisting of a surface bypass collection system, with or without secondary collection from turbine intakes;
- possible replacement of turbine runners to improve survival of juvenile salmonids that pass through the units, and limiting use of the Powerhouse 1 turbines;
- testing a forebay guidance curtain to route juvenile anadromous salmonids into surface bypass collectors;
- maintain effective predator control measures; and
- perform necessary studies to properly monitor and evaluate on-site mitigation measures.

Tributary Conservation Plan

Alternative 3 would create a Plan Species Account, to be used to collectively fund activities for the protection and restoration of Plan species habitat within the Columbia River watershed (from Chief Joseph tailrace to the Rock Island tailrace), and the Okanogan, Methow, Entiat and Wenatchee River watersheds, in order to compensate for 2 percent of the unavoidable project mortality. These habitat improvement projects could include, but not be limited to:

- providing access to currently blocked stream sections or oxbows,
- removing dams or other passage barriers on tributary streams,
- improving or increasing the hiding and resting cover habitat that is essential for these species during their relatively long adult holding period,
- improving in-stream flow conditions by correcting problematic water diversion or withdrawal structures, and
- purchasing important aquatic habitat shoreline areas for preservation or restoration.

Such tributary habitat conservation and restoration measures are expected to improve the migration and rearing conditions for all anadromous fish species. These measures are also expected to help decrease bank erosion, sedimentation, channel scouring and water quality problems. The improved conditions would increase the opportunities for successful spawning by facilitating the return of adult salmonids to their natal spawning areas at the proper time and in good health.

The funding levels for each project to the Plan Species Account are set in the HCPs. For the Wells project, the Douglas County PUD would make an initial contribution to the account of $991,000 (1998 dollars adjusted for inflation). If juvenile dam passage survival after three years of evaluations remains greater than or equal to 95 percent, the district would make annual payments of $88,089 (1998 dollars) throughout the HCP term or would pay $1,321,333 (equivalent to 15 years of annual payments), deducting the actual costs of bond issuance and interest. If juvenile dam passage survival is less than 95 percent, the Douglas County PUD shall contribute an additional $991,000 and increase the annual funding to $176,178, or make an up front contribution of $2,642,667 (equivalent to 15 years of annual payments in 1998 dollars), deducting the actual costs of bond issuance and interest.

For the Rocky Reach project, Chelan County PUD would fund the Plan Species Account at $229,800 annually (1998 dollars adjusted annually for inflation) for the term of the HCP.

For the Rock Island project, the Chelan County PUD would provide $485,200 annually (1998 dollars adjusted annually for inflation) to the Plan Species Account.

The Plan Species Account would be vested with the authority to expend money contributed by the PUDs for activities within the Columbia River watershed (from Chief Joseph Dam tailrace to the Rock Island tailrace), and including the Okanogan, Methow, Entiat and Wenatchee River watersheds to increase productivity of salmonids in the Mid-Columbia River area.

The identity, character, and magnitude of specific compensatory actions would be determined by the Tributary Committee, subject to the guidelines and standards of biological and economic efficiency and the financial resources available through the Plan Species Account.

The Tributary Committee would be composed of one representative of each of the signatory parties. The committee may select other expert entities, such as land and water trust/conservancy groups, to serve as additional, non-voting members of the Tributary Committee. The committee would be charged with the task of selecting projects and approving project budgets for the purposes of implementing the Tributary Conservation Plan.

The tributary habitat improvement projects would be determined on a case-by-case basis by the Tributary Committee, subject to the guidelines and standards of biological and economic efficiency and the financial resources of the Plan Species Account. The guidelines for tributary projects place the highest priority on maintaining and improving stream channel diversity and floodplain function. The projects would seek to conserve and protect riparian habitat to improve incubation and rearing conditions in tributary streams.

Hatchery Compensation Plan

A Hatchery Coordinating Committee would consist of one representative of each HCP signatory party. This committee would direct the effort required of each PUD for meeting the 7 percent hatchery compensation level. The initial estimated HCP hatchery production capacities for Plan species would be based on the average adult returns of Plan species for a baseline period, the 7 percent compensation requirements, and baseline adult/smolt survival rates for existing Mid-Columbia River hatcheries.

The estimated initial production capacity shall be adjusted periodically, excepting for original inundation mitigation, to achieve and maintain no net impact to the Plan species. Adjustments to the hatchery compensation level may include reduction of production to conform with actual project mortality, as determined from monitoring and evaluation, or increases in production as the base population level increases in the recovering anadromous fish populations. Hatchery compensation may be increased either by increasing the number of fish produced or by increasing the survival of fish produced at the initial production levels.

Naturally produced coho, progeny of the reintroduction efforts, will be afforded the same protection levels (no net impact and 91 percent project passage survival) as for other plan species. However, until successfully reproducing populations are reestablished, there are no hatchery compensation programs required in the HCPs.

2.3.3.9 Provisions for Unknown Impacts on Other Aquatic Species

The HCPs do not include mitigation measures for non-Plan species. However, species that actively or passively pass the project, bull trout for example, may benefit from improvements at the dams (through improved fish passage conditions). Bull trout are a threatened species in the Columbia River basin, and although they occur in the project area, the extent of their occurrence and the project-related impacts are unknown. The PUDs and FERC are currently conducting informal consultation with the USFWS to assess the potential effect of project operations on bull trout.

Aquatic species that are expected to benefit from the tributary habitat improvement projects conducted under the HCPs are Pacific lamprey and resident trout species (including bull trout) that occupy the same habitats as the Plan species. However, there are no specific provisions for enhancing or protecting these species under the HCPs.

In addition to the resident fish that typically occur in the tributaries, there are no provisions in the HCPs to enhance or protect fish species that typically occur in the reservoir areas

Terrestrial wildlife species that use riparian, wetland, and floodplain habitats are expected to benefit from implementation of aquatic habitat improvements in the tributaries. These improvements should increase their food supply, cover, and overall habitat area.

2.3.3.10 Monitoring and Evaluation

All three HCPs propose monitoring and evaluation of on-site measures to determine if the 95 percent juvenile dam passage survival standard and 91 percent project survival standard have been achieved. In addition, monitoring and evaluation of tributary habitat improvements funded by the Plan Species Account and the number of fish produced by the hatchery program would also be monitored.

2.3.3.11 Project Cumulative Effects

The PUDs would notify and consider comments from the signatory parties regarding land use permit applications on project-owned lands. The PUDs would also notify applicants seeking permits to use or occupy project lands or water that such use or occupancy may result in an incidental take of species listed under the Endangered Species Act.

2.3.3.12 Costs and Funding

Funding of all on-site measures, including studies necessary to evaluate and monitor the effectiveness of those measures, would be provided directly by the PUDs from power sale revenues. It is anticipated that bonds secured by those revenues would be issued for major capital costs, such as bypass construction. Money for the Plan Species Account would also come from project revenues, with the initial contribution possibly obtained from a bond issue.

2.3.3.13 Issuance of the Incidental Take Permit

According to Section 10 (a)(2)(B) of the Endangered Species Act, after the HCPs undergo public review and comment, Section 10 incidental take permits may be issued if the agency finds that:

- any takings would be incidental;
- the PUDs would, to the maximum extent practicable, minimize and mitigate the impacts of such takings;
- the PUDs would ensure adequate funding of the HCPs;
- any takings would not appreciably reduce the likelihood of the survival and recovery of the species in the wild; and
- that other measures required by the agency through its biological opinion would be met.

2.3.3.14 Clarification of HCP Issues

The HCPs were provided to NMFS in 1998 at which time some of the preliminary provisions were implemented pending Endangered Species Act and NEPA reviews. For example, since 1998, the PUDs have had ultimate decision on pursuit and implementation of tools to achieve the juvenile dam passage survival standard. As a result, Phase I should be completed by 2003. For Douglas County PUD, evaluation to determine whether standards have been achieved occurred during Phase I. For the Chelan County PUD, the evaluation period would likely follow Phase I. Several inconsistencies have resulted from this phased implementation approach, and a number of technical issues have arisen during the initial implementation efforts. The following sections attempt to clarify these inconsistencies and issues. The terms of the HCPs are expected to be modified as necessary to reflect these clarifications.

Term of the HCPs

Phase I would continue through 2003, although the 50-year term of the HCPs would not begin until the incidental take permits are issued. Based on the current schedule, the terms of the HCPs should be from April 2002 through March 2052. Payments to the Plan Species Account would be initiated when the incidental take permits are issued, and adjusted for inflation from 1998.

Transition Period

Because measures common to Phase 1 of the HCPs have been conditionally implemented by the PUDs (even though the HCPs have not been agreed to by all parties at this time), the PUDs have had the ultimate authority on pursuit and implementation of specific bypass measures since 1998. However, the existing FERC license articles, settlement agreements and stipulations remain in effect to address dispute resolution proceedings, spill volumes, and hatchery compensation levels. Components of the HCPs that address each of these issues would not be implemented until the agreements have been ratified. In order to address ongoing Endangered Species Act issues, FERC and NMFS have been consulting over interim protection plans that would remain in affect until April 2002, or until the HCPs are ratified (whichever comes first). If the agreements have not been ratified by April 2002, FERC would be required to reinitiate consultation with NMFS under Section 7 of the Endangered Species Act at which time additional measures may be required.

Verification of Standards

In order to determine if the HCPs survival standards are being met, specific biological and statistical standards have been established in the HCPs. These standards apply to all of the evaluations to be conducted. Because the available technology is not sufficient to adequately conduct all of the evaluations proposed in the HCPs for each of the Plan species, representative survival studies would be conducted for yearling chinook salmon and steelhead. Indirect methods of measuring compliance would be developed for each of the remaining plan species. The results would be utilized to support decisions made under Phase I of the HCPs and efforts to determine more direct compliance with the standards for all species would continue during phases II and III.

Survival studies of yearling chinook salmon and steelhead were initiated at the Wells Project in 1998 and will be initiated at the Rocky Reach and Rock Island projects by no later than 2003. Initial verification of the 95 percent juvenile dam passage survival standard is expected to take 3 years.

Currently, the 95 percent juvenile dam passage survival standard cannot be verified for subyearling chinook (summer/fall chinook) or for sockeye salmon and the 91 percent total project survival standard (which includes the survival of the adult life stages) cannot be verified for any of the Plan species. There is currently no methodology that all parties support for determining the survival of adult fish through the projects. Therefore, information pertaining to the juvenile life stages and compliance with the juvenile dam passage survival standards would be the basis for determining if the standards have been met.

The HCPs provide a mechanism for future verification of the 91 percent total project survival standards for each of the Plan species, as the appropriate technology is developed and supported by the Coordinating Committees.

Wells Project

Because the Wells Project has an existing bypass system, juvenile survival studies were initiated before the end of the Phase I time frame. Douglas County PUD conducted juvenile survival studies in 1998 using yearling chinook salmon, and in 1999 and 2000 using yearling steelhead. Although not required under Phase I of the HCP, it is anticipated that a fourth year of juvenile survival studies will be conducted in 2001, using yearling chinook salmon. Additionally, the Douglas County PUD conducted 3 years of fish passage efficiency evaluations (an estimate of the number of juvenile fish bypassing the project through the surface bypass system) for the Wells project bypass system.

These studies indicated that 92 percent of the spring-run migrants (yearling chinook, steelhead, and sockeye) and 96 percent of the summer-run migrants (summer/fall chinook) use the bypass system. Based on the best estimate of turbine and bypass survival (91.2 and 98 percent, respectively), spring-run migrants are expected to have a juvenile dam passage survival rate of 97.5 percent and summer-run migrants are expected to have a 97.7 percent juvenile dam passage survival rate.

The determination of whether the Wells project is meeting the HCP survival standards would initially be based upon the results of the project survival studies conducted for yearling chinook salmon and steelhead, and an indirect assessment of juvenile survival for each of the remaining Plan species. Throughout the term of the HCP, the 95 percent juvenile dam passage survival standard and the 91 percent total project survival standard would be re-evaluated from time to time as determined necessary by the Coordinating Committee. It is anticipated that, as technology is developed; sockeye and subyearling chinook salmon, as well as adult salmon, and steelhead survival studies would be conducted.

Funding for the Tributary Conservation Plan for the Wells project is tied directly to the survival standards. If it is determined that the Wells total project survival standard is equal to or more than 95 percent, Douglas County PUD's contribution to the tributary fund would be one-half of the expected contribution. If the total project survival standard is determined to fall below 95 percent, Douglas County PUD would contribute prospectively, for the remaining time of the HCP, the equivalent of a full 2 percent credit to the tributary fund.

Until the Coordinating Committee develops methodologies to evaluate the adult project passage survival component of the total project survival standard, the results of the juvenile survival studies (including both the direct and indirect effects of dam and reservoir related survival) would singularly determine Douglas County PUD's contribution to the Plan Species Account. Therefore, if 95 percent juvenile project survival is met, the fund would be one-half of the expected contribution.

Rocky Reach Project

The Chelan County PUD is developing a surface bypass collector system for the Rocky Reach project. At the conclusion of Phase I, or earlier if the Coordinating Committee concurs, Chelan County PUD will initiate 3 years of survival studies for yearling chinook salmon and steelhead to verify that the 95 percent juvenile dam passage survival standard is being met. As is the case with the Wells Project, the best available information will be used to determine whether the juvenile dam passage survival standard has been met for each of the remaining Plan species (e.g., survival information from surrogate species combined with measurements of fish passage through non turbine routes). Throughout the term of the HCP, the 95 percent juvenile dam passage survival standard and the 91 percent total project survival standard will be re-evaluated from time to time as determined necessary by the Coordinating Committee.

Rock Island Project

Spill is the currently the preferred juvenile bypass measure at Rock Island Dam. At the end of Phase I (or earlier if the Coordinating Committee concurs) Chelan County PUD will initiate 3 years of survival studies for yearling chinook salmon and steelhead to verify that the 95 percent juvenile dam passage survival standard is being met. As is the case with the Wells and Rocky Reach projects, the best available information will be used to determine whether the juvenile dam passage survival standard has been met for each of the remaining Plan species (e.g., survival information from surrogate species combined with measurements of fish passage through non turbine routes). Throughout the term of the HCP, the 95 percent juvenile dam passage survival standard and the 91 percent project survival standard will be re-evaluated from time to time as determined necessary by the Coordinating Committee.

Compensation for Unavoidable Project Mortality

During the development of this EIS, certain sections of the HCPs required clarification to allow for accurate analysis of the potential affects of the actions on Endangered Species Act-listed species and on other natural resources. Most of the clarifications related specifically to modification of the standards to ensure no net impact. It should be noted that HCP survival standards are fixed and compensation will not vary if the standards are not being met. Hatchery compensation would not be increased to 9 percent; for example, if dam passage survival is only 93 percent for a given species. The 2 percent shortcoming in the juvenile dam passage survival standard would be addressed through improvements in dam passage survival. Likewise, if the 7 percent hatchery compensation level is not met due to NMFS Endangered Species Act concerns, neither the dam passage survival standard, the project survival standard, nor the habitat compensation standard would be adjusted.

Hatchery Compensation Plan Issue

During the development of the HCPs, NMFS determined that the 7 percent hatchery compensation levels may adversely affect wild salmon populations under certain conditions. For example, it may be necessary to use adult salmon and steelhead that are not adapted to the local habitat conditions in order to produce enough juvenile fish to meet the 7 percent compensations level. In order to ensure that these compensation levels do not affect the long-term health of the wild populations, all fish produced under this program must be from local stocks. Therefore, until the specific details of the compensation programs are developed, including identification of appropriate broodstock, maximum percentages of the wild populations that can be trapped for broodstock, and the total number of fish produced through artificial means, NMFS can not guarantee that the 7 percent compensation level will satisfy Endangered Species Act requirements and no net impact would not be achieved.

Although several of the affected Columbia basin treaty Tribes made significant comments during the scoping process associated with this EIS, a major concern was NMFS' reluctance to guarantee the 7 percent compensation levels. These levels were a key component of achieving and maintaining no net impact and a crucial portion of tribal consideration for the HCPs. Without a guarantee from NMFS that the 7 percent compensation levels would be attained, the Tribes will not endorse the HCPs.

2.3.3.15 Recent HCP Revisions

On June 1, 2000, the USFWS and NMFS published a final addendum to the Handbook for Habitat Conservation Planning and Incidental Take Permitting Process. This addendum, which is also known as the five-point policy guidance, provides clarifying direction on five issues brought forth from recent HCPs implemented throughout the

United States. Described below is how the applicant HCPs meet the HCP addendum.

Biological Goals and Objectives

The addendum recommends that biological goals and objectives be incorporated in HCPs. These goals may be either habitat or species based. Species-based goals are expressed in terms specific to individuals or populations of that species. The performance standards identified in Section S.5.3.5 represent the biological goals and objectives for the HCPs (i.e., the HCP standards). These standards require specific survival goals based on the population passing through each project. In addition, incidental mortality is mitigated through hatchery production and habitat improvements to achieve an overall no net impact standard.

Adaptive Management

The use of an adaptive management strategy is recommended to (1) identify uncertainties related to quantifying the achievement of goals and objectives of the HCPs as well as the questions that need to be addressed to resolve these uncertainties; (2) develop alternative strategies and determine which experimental strategies to implement; (3) integrate a monitoring program that is able to detect the necessary information for strategy evaluation; and (4) incorporate feedback loops that link implementation and monitoring to a decision-making process that results in appropriate changes in management. Adaptive management would be incorporated into the HCP monitoring programs that provide the feedback necessary to determine the effectiveness of various approaches being implemented to increase fish survival. Throughout the term of the HCP, what is learned would be used to adjust conservation measures.

Monitoring

HCP handbook guidance on monitoring recommends that the monitoring program reflects the measurable biological goals and objectives. The monitoring programs developed under the HCPs are two-fold: (1) to confirm fish survival through the dams, and (2) evaluate the effectiveness of on-site mitigation measures implemented to improve fish survival.

Permit Duration

Factors to be evaluated when determining permit duration include the time line of the proposed activities and the expected positive and negative effects on covered species associated with the proposed duration. The HCP terms generally compliment the term of a project operating license, but more importantly reflect a desire to provide long-term protection assurances for the Plan species that also account for oceanic condition changes that may occur over a longer period of time.

Public Participation

The HCP handbook amendment recommends a 90-day public comment period for large-scale, regional, or complex HCPs. The public review period for the Wells, Rocky Reach, and Rock Island HCPs will occur over a 90-day period.

2.4 ACTIONS COMMON TO ALL ALTERNATIVES

Only those project operations that affect fish passage would be altered, if necessary, to assist in increasing the overall salmon and steelhead survival rates. Studies to evaluate and improve fish passage have been ongoing since the dams were constructed. As a result, the key factors influencing fish passage have already been identified. Project operations that are included under all of the alternatives are:

- fishways,
- fishladders,
- fish bypass,
- turbine operations,

- predator removal,
- hatcheries, and
- spill.

The four tributaries where funds for the Plan Species Account would be directed under the HCP (Wenatchee, Entiat, Methow, and Okanogan) have threatened (bull trout) and endangered (spring-run chinook and steelhead) species. Numerous efforts are being, or will be, implemented to improve fish survival and breeding opportunities in the streams that are unrelated to the operation of the Wells, Rocky Reach, and Rock Island dams or the HCPs. These improvement activities would continue under all alternatives.

2.5 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

During the scoping process of this EIS, several other *independent* alternatives were considered but eliminated from further analysis for two main reasons: Either (1) the alternative in itself did not allow for the continued operation of the hydroelectric projects, or (2) the alternative did not satisfactorily address the entire range of issues affecting Endangered Species Act-listed species. These independent alternatives are described in more detail in the following sections.

Note that all alternatives in this EIS contain several specific measures that may be implemented at each project. By themselves, these measures are unlikely to result in recovery of Endangered Species Act-listed salmonid species or to significantly enhance the number of unlisted salmonids returning to the basin. Each measure typically affects just one component of a multi-faceted problem and either impact other areas of the salmonid life cycle or inadequately provide the protection necessary to recover the species to harvestable levels without the concurrent implementation of additional measures. Where appropriate however, specific components of these measures are included in the two action alternatives. Included below is a discussion of why individual protection measures were not considered as unique alternatives.

2.5.1 DAM REMOVAL

Dam removal would return the Mid-Columbia River to a free flowing state that would arguably provide the greatest benefits to salmon and steelhead. The dam passage impacts would be eliminated and additional spawning and rearing habitat would be created. Dam removal is extremely controversial, and can only be legally mandated at project relicensing. Over the next 12 years, the removal of Wells and Rocky Reach dams would be considered and addressed, under the relicensing efforts for the projects, if requested by interested parties. Dam removal for the Rock Island project would not be evaluated until 2029, when its license is up for renewal.

Under the shortest possible time frame, it is likely that the decision to remove a dam would require up to 10 years, with an additional number of years needed to develop the procedures and to execute the deconstruction efforts. As an example, removal of the four lower Snake River dams has been studied in detail over the last 4 years, the previous 3 years spent evaluating drawdown alternatives. The NMFS is currently recommending several more years of study before they make a final recommendation. Following this recommendation, the U.S. Congress would likely have to consider and vote on any dam removal efforts.

A similar process can be expected for removal of the Mid-Columbia River dams, if initiated during project relicensings. Throughout these studies and discussions, salmon and steelhead would continue to decline, possibly to extinction. Therefore, due to the legal constraints associated with mandating dam removal, the time involved, and the interim impacts to both juvenile and adult salmonids, dam removal is not considered a reasonable alternative and was not considered in detail.

2.5.2 JUVENILE FISH BYPASS SYSTEMS

Although juvenile fish bypass systems would be included as a part of all the alternatives evaluated in detail, they would not provide sufficient protection for the recovery of the species as an independent alternative. Therefore, this alternative was not evaluated in detail. A juvenile fish bypass system provides a passage route around a dam's turbine units. It consists of a collection area that allows fish to enter the system from the project's forebay, a bypass conduit that transports fish around the dam, and an outfall located downstream of the project. Although existing spillway structures and ice and trash sluiceways (conduits designed to pass debris over a dam) can be relatively effective at passing fish, the term juvenile bypass system usually refers to a facility specifically designed and suited to this task.

Bypass systems using standard length turbine intake guidance screens, currently in operation on the lower Columbia and Snake rivers, typically pass approximately 70 percent of yearling salmonid outmigrants (stream-type chinook, steelhead and sockeye). These systems are less effective for subyearling outmigrants (ocean-type chinook) (approximately 50 percent) and they pose a significant risk of injury to sockeye and juvenile lamprey. Although extended length screens have improved the guidance of these systems to a degree, stress and injury continues to occur, and comparatively extensive operations and maintenance efforts can reduce their overall effectiveness.

Surface-oriented bypass systems typically provide juvenile fish passage without incorporating guidance screens. Entrances to these systems are designed to intercept juvenile salmon and steelhead in the upper part of the water column, before the fish enters the turbine unit intakes. Although preferable to screened bypass systems, only the Wells Dam surface bypass system has been consistently efficient at attracting and passing substantial numbers of juvenile salmonids. Developmental surface bypass systems are under investigation at the Rocky Reach and Rock Island dams, but it may be necessary to provide some additional protection and enhancement measures to meet the established survival levels. Therefore, although juvenile bypass system development, construction, and operation is included in each of the alternatives, it is not expected to be an adequate alternative in and of itself.

2.5.3 SPILL

In most cases, spill is an effective means of bypassing salmon and steelhead around a dam. However, spill alone would likely not provide sufficient protection for listed species without considerable impacts to other natural resources. In studies conducted on the lower Columbia and Snake rivers, spill has consistently resulted in higher survival levels for juvenile salmonids than for any other bypass methodology tested. However, the quantity of spill required to bypass significant numbers of juvenile fish may result in increased total dissolved gas levels and affect other water quality parameters.

When water is discharged over a spillway, air is drawn into the tailwater as flow plunges deep below the water surface. As this air reaches the higher pressures associated with increasing water depths, the air is forced into the water column. Increasing levels of spill draws increasing volumes of air to depth, forcing higher levels of the atmospheric gasses into the water. High concentrations of some of these gasses (e.g., nitrogen) can be deadly to fish and other aquatic organisms. Therefore, the amount of water that can be discharged over a given spillway is limited by the amount of atmospheric gasses that are introduced into the tailwater.

At lower spill levels, the volume of water discharged typically passes proportionately higher numbers of fish. For example, if 20 percent of the total river flow is spilled, up to 40 percent of the juvenile salmonids may bypass the dam via the spillway. As the spill volume increases, to 60 percent for example, only 60 percent of the juvenile salmonids might pass the spillway. In many cases, 60 percent spill is at or above the maximum level allowed given the entrainment of atmospheric.

Spill is currently the primary measure to pass juvenile fish at Rock Island Dam, and is the primary measure proposed under Alternative 3 for Rock Island. It is also a component of the Wells Dam bypass system. However, it is not as effective at the Rocky Reach Dam. Spill is a component of the alternatives considered in detail, and will likely assist in meeting the overall survival requirements. In and of itself, however, it is not expected to satisfy all of the needs of the listed species and was therefore eliminated as an independent alternative for detailed consideration.

2.5.4 FISH TRANSPORTATION

An alternative method of fish passage is to collect juvenile salmon and steelhead at dams as they migrate downstream and then transport the fish by truck or barge around the downstream dams and reservoirs. Advantages of fish transportation include protection from direct and cumulative turbine passage mortality, from predation in the reservoirs and tailraces, and from gas supersaturation caused by excessive levels of spill. Transportation can also help to minimize delays in migration that are caused by slack water in the reservoirs between dams.

Transportation additionally requires the construction of juvenile bypass systems that include dewatering structures and separator facilities to enable barge and truck loading facilities. The transportation program is also limited by the ability of the mechanical bypass systems to effectively attract juvenile salmonids. Under certain conditions, transportation may also result in lower adult returns and may increase the level of straying. Currently, fish are transported in the lower Snake and Columbia rivers where bypass and separator facilities have been constructed, although it has not occurred at the three project dams (Wells, Rocky Reach, and Rock Island).

Given the requirement to design, construct and install juvenile bypass, separator and loading facilities, transportation is not a valid option in and of itself. In addition, due to the potential stress, injury and mortality to juvenile salmonids associated with these systems, and the expectation that guidance efficiencies will fall short of supporting the required survival levels, this alternative has been eliminated from consideration as either a stand alone option or a measure to be included in the two action alternatives addressed in this EIS.

2.5.5 ARTIFICIAL FISH PRODUCTION

The assumption governing this alternative is that juvenile and adult salmonids that are killed incidentally to project operations can be replaced by juvenile fish produced in a hatchery. Increases in production would likely occur at each of the existing hatcheries, and the number of juvenile fish produced would be based on the calculated fish passage mortality rate attributed to each dam. The goal of this effort would be to mitigate up to 100 percent of the dam related passage mortality.

Based on several decades of hatchery mitigation and enhancement activities, it is now clear that this methodology alone will not recover Endangered Species Act-listed species or satisfactorily enhance naturally producing unlisted salmonid populations in the Columbia River basin.

Hatchery fish can have direct and indirect affects on wild fish populations. Competition between the larger hatchery reared juvenile salmon and steelhead and the smaller wild juvenile salmon and steelhead for food and space and the predation that is likely to occur between these populations may impact the wild fish. In addition, outplanting non-indigenous hatchery reared juveniles into local habitats further reduces the integrity of the wild populations by increasing the likelihood of genetic mixing. This results in a dilution of the wild gene pool which affects the long-term health and viability of the wild populations.

As more and more hatchery fish are produced, wild stocks continue to be diluted in comparison to hatchery stocks, ultimately resulting in fewer and fewer wild fish. This continued decrease in the population of wild fish does not meet the objective of recovering an endangered or threatened species. Although limited artificial supplementation efforts utilizing locally adapted stocks would likely be a component of each alternative to help prevent the extinction of listed species, and to compensate for a certain level of mortality for unlisted species, additional measures are required to ensure the species' long-term protection and enhancement. Therefore, based on the disadvantages associated with excessive supplementation levels, this alternative was eliminated from detailed consideration.

2.5.6 SEASONAL RESERVOIR DRAWDOWN

Seasonal reservoir drawdown refers to lowering the water level of the lake located immediately upstream of a dam during juvenile fish migration periods. This concept was initially developed on the lower Snake River to reduce the time it takes water (and incidentally, juvenile salmon and steelhead) to travel through the reservoirs. Studies on the lower Snake River correlated increased water particle travel time with fish migration rates and have generally inferred that this would result in higher juvenile salmon and steelhead survival. Although there is limited data on actual survival improvements, modeling data suggest that high flow conditions provide greater survival (particularly for steelhead) (BPA et al. 1994a; NMFS 1998). To decrease water particle travel time, either additional flow must be provided through the reservoir or the cross sectional area of the reservoir must be reduced. Drawdown reduces the cross sectional area of project reservoirs.

As the concept of reservoir drawdown was more thoroughly developed on the lower Snake River, lowering the reservoir to slightly above the spillway crest was evaluated. This level of drawdown was intended to create sections of free flowing river in the tailrace areas of the next upstream dam, and thus return the river to a more natural state. Conceptually, the Army Corps of Engineers considered that these increased levels of drawdown would only be required during the fish passage seasons. However, significant modifications would be necessary to the existing fish passage facilities and the seasonally fluctuating reservoirs would impact existing wildlife, riparian and salmon and steelhead spawning and rearing habitats. Significant loss of power production would also occur as would impacts to irrigation, municipalities and industry.

On the Mid-Columbia River, higher flows have been correlated to improved survival for steelhead. However, no correlation was identified for the other salmonid species. Therefore in and of itself, improving water particle travel time will not significantly improve conditions for all Endangered Species Act-listed or unlisted species. In addition, seasonal spillway crest drawdowns have a considerable number of associated habitat impacts that render this option impractical. It is therefore not considered a realistic alternative and has not been evaluated in this analysis.

2.5.7 NON-POWER OPERATIONS

Section 15 (b) of the Federal Power Act, authorizes FERC to issue a license for non-power use when it "finds that, in conformity with a comprehensive plan for improving or developing a waterway or waterways for beneficial public uses, all or part of any licensed project should no longer be used or adapted for use for power purposes." If non-power licenses were granted to any of the Mid-Columbia River dams, power production would presumably cease (except for potential emergency power requirements of the project) and all the flow would pass through the spillways and fishways. No entity has recommended issuance of a non-power license, and this would only occur at the time of relicensing. Note that dam decommissioning and possibly seasonal reservoir drawdown would result in non-power operations.

2.6 ALTERNATIVE COMPARISON

2.6.1 ALTERNATIVE 1 (NO-ACTION)

Because each of the alternatives strive to improve fish survival at the dams, environmental differences among the alternatives at the project site are somewhat less significant than the procedural differences between Endangered Species Act Section 7 consultations (Alternative 2) and Section 10 permit processes (Alternative 3) as shown in Table 2-7 and described below.

The most significant differences among the alternatives are the scope of the species covered, the statutory obligations covered, the parties that support the alternatives, and the speed at which each alternative could be implemented. Alternative 1, current FERC license requirements, addresses all species but may or may not address the additional requirements of the Endangered Species Act. Alternative 2 creates a long-term protection plan between FERC and NMFS only for listed upper Columbia River steelhead and spring-run chinook salmon and requires a new consultation at the time each project is re-licensed. Measures under Alternative 2 are not currently supported by FERC or the licensees, which may lead to a delay in implementing actions. Alternative 3, the HCPs, are long-term settlements of salmon and steelhead issues at each project under the current license and at relicensing. The settlements cover statutory obligations in addition to the Endangered Species Act, and apply to any party that signs the HCP agreements. The HCPs were originally developed by the PUDs along with NMFS; FERC; USFWS; the Yakama, Colville, and Umatilla Indian Nations; American Rivers, Inc., and each project's wholesale power purchasers.

Table 2-7 compares the alternatives, and the text in Sections 2.6.2 through 2.7.2 below describes the major differences between the alternatives. Note that the following information is not intended to identify every possible scenario that may result under each alternative, only to address the major procedural differences in the alternatives, and to highlight some of the fundamental protection differences.

2.6.2 AFFECTED SPECIES

2.6.2.1 Alternative 1 (No Action)

Protection for the listed and non-listed anadromous salmonid species would be provided through the existing FERC licenses (and future relicensing procedures). Existing measures however, may not prevent the extinction of listed species. Additional Federal laws, primarily the Federal Power Act, could be utilized to seek protection, mitigation, and enhancement measures for steelhead, spring-run chinook salmon, summer/fall chinook salmon, and sockeye salmon during project relicensings and through license re-opener clauses.

2.6.2.2 Alternative 2

Authorities afforded to NMFS under the Endangered Species Act would apply to upper Columbia River steelhead, upper Columbia River spring-run chinook salmon, and Mid-Columbia River steelhead. Protection, mitigation, and enhancement measures for summer/fall chinook and sockeye salmon would be addressed as in Alternative 1.

2.6.2.3 Alternative 3

The HCP applies to Upper Columbia River steelhead, upper Columbia River spring-run chinook salmon, sockeye salmon, summer/fall chinook salmon, and coho salmon (although the wild population of coho salmon has been extirpated from the action area, the HCPs provide measures to protect reintroduced populations). Although the impacts to Mid-Columbia River steelhead are likely limited to water quality issues, this species is not specifically addressed in the HCP agreements.

TABLE 2-7. ALTERNATIVE COMPARISON

ACTION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Endangered Species Act compliance	None	Section 7 (a)(2)	Section 10 (a)(1)
Duration of each Alternative	Not applicable	Current license term, modified as needed based on new information – consultation reinitiated at relicensing	50 years subject to withdrawal and termination provisions
Species Covered	Anadromous fish in general	Upper Columbia spring-run chinook Upper Columbia steelhead (Permit species)	Spring-run, summer and fall chinook, summer steelhead, sockeye salmon, and coho salmon (Plan species)
Protection Measures	Limited spill and bypass measures, continued operation of adult fishways	Additional project operational and structural modifications for listed species only and habitat improvements if necessary to prevent the extinction of listed species	Additional project operational and structural modifications for all Plan species and immediate implementation of habitat improvement measures
Performance Standards	Currently based on fish passage efficiency for specific measures (no project or species level standards)	The species' persistence, as listed or as a recovery unit, beyond the conditions leading to its endangerment, with sufficient resilience to allow for the potential recovery from endangerment	No Net Impact - 91% overall fish passage survival (juvenile and adult) with an independent standard of 95% juvenile survival through the forebay, dam and tailrace. Compensation to obtain no net impact also includes 7% to hatchery programs and 2% to tributary programs
Project Lead for Identifying and Implementing Protection Measures	FERC	FERC in consultation with NMFS	HCP Coordinating Committees
Location of Fish Protection Measures	Area of project including reservoir, dam structures, tailrace, and hatcheries	Area of project including reservoir, dam structures, tailrace, and hatcheries. Tributary improvements may be proposed if necessary to prevent the extinction of listed species	Area of project including reservoir, dam structures, tailrace, and hatcheries and additionally includes Wenatchee, Entiat, Methow, and Okanogan rivers and tributaries, as well as associated hatcheries and agreement on the habitat improvement process
No Surprises Policy	Not applicable	Not applicable	Applicable
Continued Studies to Assess Survival	Yes for Wells, but only to verify fish passage measures at Rock Island and Rocky Reach	Yes	Yes

TABLE 2-7. ALTERNATIVE COMPARISON (CONTINUED)

ACTION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Monitoring Following Statement/Permit Issuance	Limited	As needed to ensure effectiveness of measures and status of listed species	Significant throughout the term of the agreement for all Plan species
Future Provisions for Other Aquatic Species	Would occur under relicensing or under existing license reopener clauses	Same as Alternative 1	Same as Alternative 1
Hatchery Compensation	Continued hatchery funding at present level, for inundation compensation levels and ongoing unavoidable losses (hatchery compensation can be adjusted for Wells base on actual losses)	Same as Alternative 1, although may be refined based on effects to listed species	Continued hatchery funding for inundation compensation levels. Hatchery funding for ongoing unavoidable losses would be set to achieve 7 percent compensation levels, unless reduced to prevent jeopardy to listed species
Tributary Improvements	No PUD-funded improvements	Potentially, if necessary to prevent the extinction of listed species (implemented in lieu of non-power measures)	PUD contributions to the Plan Species Account would pay for projects that improve salmon and steelhead habitat in the Wenatchee, Entiat, Methow, and Okanogan river basins, as well as the Mid-Columbia River mainstem. Monetary amount is specified in the HCPs
On-Site Protection Measures			
Wells	Adult Passage: Continue operation and maintenance of adult fishways, evaluate and improve fishway operations, conduct modeling and develop solutions for adult fish passage problems, use spillway flow configurations to optimize adult fishway attraction flows	Adult Passage: Same as Alternative 1 or as needed to prevent the extinction of listed species	Adult Passage: Meet 91% overall survival standards (including juvenile and adults) for all Plan species
	Juvenile Passage: Evaluate and control total dissolved gas, continue predator control program. Operate surface bypass system 24-hours/day to achieve 70-80% FPE	Juvenile Passage: In addition to measures in Alternative 1: Operate turbines at peak efficiency ratings, operate surface bypass system 24 hours/day for 95% of juvenile spring-run chinook and steelhead migrations, increase spill as needed to prevent the extinction of listed species	Juvenile Passage: Meet 95% dam passage survival for all Plan species by increasing effectiveness of juvenile bypass system, spill gates, predator control, and turbine usage. Applicant has opportunity of selecting options that, when combined, meet survival standards
Rocky Reach	Adult Passage: Continue to operate and maintain adult fishladders	Adult Passage: Continue operation and maintenance of adult fishways, evaluate and improve fishway operations, conduct modeling and develop solutions for adult fish passage problems, use spillway flow configurations to optimize adult fishway attraction flows	Adult Passage: Same as Wells (above)

TABLE 2-7. ALTERNATIVE COMPARISON (CONTINUED)

ACTION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
	Juvenile Passage: Spill 15% of daily river flow for up to 30 days during spring migration period and 10% for 34 days during the summer migration, evaluate and construct a permanent bypass system and replace old turbine runners	Juvenile Passage: In addition to measures identified in Alternative 1, increase spill as necessary to prevent the extinction of listed species	Juvenile Passage: Same as Wells (above)
Rock Island	Adult Passage: Continue to operate and maintain adult fishladders	Adult Passage: Same as for Rocky Reach (above)	Adult Passage: Same as Wells (above)
	Juvenile Passage: Provide spill as requested by fish agencies and Tribes through the a Fish Conservation Account	Juvenile Passage: In addition to measures identified in Alternative 1, increase spill as necessary to prevent the extinction of listed species, enhance spillway passage efficiency, preferentially use Powerhouse 2 turbines, and minimize use of Nagler turbines	Juvenile Passage: Same as Wells (above)
Dispute Resolution	Disputes resolved by FERC and/or in court	Disputes are resolved by NMFS, FERC and/or in court	Disputes resolved by mediation and binding arbitration, and includes expedited dispute resolution procedures to resolve some disputes within 30 days
		Other measures as required by NMFS to ensure protection and recovery of the listed species	

2.6.3 PROCEDURAL DIFFERENCES

2.6.3.1 Alternative 1 (No Action)

Provisions of this alternative would be implemented through FERC proceedings, which currently include use of Coordinating Committees. The committees consist of members representing fishery agencies, Tribes, and PUDs. The protection measures implemented through this process require unanimous consent of all parties. This can, and has resulted in contested proceedings and legal debates among the parties that have significantly delayed implementation of fish protection measures. This alternative does not provide direct protection for listed species, and therefore may not necessarily satisfy Endangered Species Act requirements.

2.6.3.2 Alternative 2

Under Alternative 2 (Endangered Species Act Section 7 consultations for listed species), NMFS has the legal authority to determine the actions necessary to ensure the survival and recovery of listed species. This includes determining the most appropriate measures to be taken at each project, determining the necessary level of survival at each project, determining the most appropriate data to be considered when evaluating survival; and modifying the measures as needed if species continue to decline. The FERC, as the action agency, must comply with these actions in order to be exempt from the take prohibitions as described under Section 9 of the Endangered Species Act. Under Section 7, NMFS has a legal responsibility to provide the benefit of the doubt to listed species with respect to gaps in the information base.

If FERC or the PUDs disagree with NMFS' decisions under this process, lengthy legal proceedings may ensue. During these proceedings, measures in addition to those already included in the FERC-issued operating licenses and settlement agreements are not likely to be implemented.

Species not listed under the Endangered Species Act would be addressed as in Alternative 1.

2.6.3.3 Alternative 3

According to provisions in the HCPs, the authority to determine the appropriate protection measures for all of the Plan species, including the Endangered Species Act-listed species, fundamentally shifts away from NMFS under Alternative 3 (HCPs) once the incidental take permit has been issued. During Phase I of the HCPs, the PUDs would have the ultimate authority to determine the measures necessary to achieve the survival standards. During Phase II, a Coordinating Committee (comprised of the PUD responsible for the HCP, NMFS, and each of the signatories to the agreement) jointly decides on the appropriate measures. If the Coordinating Committee cannot reach consensus, the PUDs may continue to determine the appropriate measures unless the matter is addressed through the dispute resolution process.

The party bringing an issue to dispute resolution must prove its case by a preponderance of the evidence. There is no requirement to provide the benefit of the doubt to the species of concern with respect to gaps in the information base and NMFS has no authority to determine what constitutes the best available information to be utilized in support of any decisions. The dispute resolution process is limited to under five months, ensuring that lengthy legal disputes would not occur, and decisions reached through the dispute resolution process are binding. As a result, specific measures are likely to be implemented more expeditiously than could be expected under Alternative 2. If the standards are achieved by 2003, they would be maintained by the PUDs throughout the term of the agreement.

Because the HCPs set out certain actions, responsibilities, and duties to be carried out by the PUDs, each of the signatories to the agreements agrees not to institute any action under the Endangered Species Act, the Federal Power Act, the Fish and Wildlife Coordination Act, or the Pacific Northwest Electric Power Planning Conservation

Act. In addition, NMFS' no surprises policy (which ensures the PUDs that NMFS would not request additional measures during the term of this agreement) would be in effect.

2.6.4 TIME FRAME

2.6.4.1 Alternative 1 (No Action)

Fish protection measures included in this alternative would occur throughout the term of the FERC-issued operating licenses. They may not, however, represent sufficient protection for Endangered Species Act-listed species. In any case, project operations would continue as occurs presently regardless of future listings or delisting. FERC license periods are typically 30 to 50 years, although the three Wells, Rocky Reach, and Rock Island projects would be relicensed over the next 29 years. Additional fish protection measures would likely be implemented during relicensing.

2.6.4.2 Alternative 2

Specific measures required for Endangered Species Act-listed species would be in effect throughout the term of the FERC-issued operating licenses or until the species status warranted delisting. FERC would be required to reconsult under Section 7 of the Endangered Species Act prior to issuing any new project operating licenses or amendments (measures initiated under the Federal Power Act for unlisted species would be in effect through the FERC license period [typically 30 to 50 years]). Section 7 consultation would be reinitiated, and additional measures potentially required, as new information is developed under the research and monitoring programs.

2.6.4.3 Alternative 3

The HCPs would be in effect for a 50-year period beginning with the date that the agreements are legally ratified by each of the signatories (currently expected to be April 2002 through March 2052).

2.6.5 GOALS AND OBJECTIVES

2.6.5.1 Alternative 1 (No Action)

This alternative may not provide specific provisions to ensure the continued existence or recovery of Endangered Species Act-listed fish species. Protection measures would continue to be implemented in accordance with existing FERC license articles and settlement agreements. Goals and objectives tend to be specific for each measure at each dam (i.e., no project or species level standards).

2.6.5.2 Alternative 2

The Endangered Species Act Section 7 process is specifically intended to ensure the continued existence of listed species with an adequate potential for recovery. The manner in which the projects are operated is based upon a biological opinion issued by NMFS to FERC, and a FERC order issued to the PUDs.

2.6.5.3 Alternative 3

The HCPs guarantee 100 percent no net impact for each of the Plan species.

2.6.6 ADDITIONAL MEASURES

2.6.6.1 Alternative 1 (No Action)

This alternative does not provide a procedure to force implementation of mitigation measures beyond the project's boundaries (i.e., tributary habitat improvements). Under Alternative 1, hatchery supplementation is addressed through the existing settlement agreements between FERC and the PUDs, the existing license articles, or through the relicensing procedures.

2.6.6.2 Alternative 2

The Endangered Species Act Section 7 process typically does not address off site mitigation (i.e., habitat improvement) that has not been affected by the proposed action. However, NMFS would likely propose offsite actions prior to investigating any non-power measures, if protection measures implemented at the projects have been fully utilized and the species continue to decline. Under Alternative 2, supplementation is addressed through the existing settlement agreements between FERC and the PUDs or during relicensing. If NMFS determines that the current hatchery production levels would compromise the genetic integrity of wild fish, the production levels would be reduced.

2.6.6.3 Alternative 3

The HCPs include a funding process for the protection and restoration of Plan species' habitat within the Columbia River watershed (from the Chief Joseph Project tailrace to the Rock Island Project tailrace) and in the Okanogan, Methow, Entiat, and Wenatchee River watersheds. In addition, hatchery compensation plans guarantee funding and capacity to meet the 7 percent compensation level necessary to achieve no net impact.

2.6.7 OTHER ENVIRONMENTAL MEASURES

Table 2-8 provides a summary comparison of how the proposed fish protection measures affect other environmental resources in the project area.

TABLE 2-8. ENVIRONMENTAL COMPARISONS OF THE ALTERNATIVES (PAGE 1 OF 8)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Land Features, Geology, and Soils			
Project Area Soils	Same as existing conditions	Same as Alternative 1. If reservoir drawdown occurs, river cross sectional areas would decrease to the original size of reservoirs	Same as Alternative 2
Reservoir Erosion and Sedimentation	Same as existing conditions	Same as Alternative 1. If reservoir drawdown occurs, erosion and reservoir turbidity would initially increase over the short term and damage aquatic habitat conditions with the greatest damage occurring the first 4 to 7 years. Turbidity would decrease over time and habitat conditions would improve	Same as Alternative 2
Tributary Channel and Watershed Conditions	Geologic conditions conducive to fish habitat are expected to improve from independent local and State funded fish habitat enhancement projects	Same as Alternative 1. If reservoir drawdown occurs, tributary channel mouths would erode each year, over the first 7 years	Same as Alternative 2 with additional improvements to stream geomorphic conditions through the PUD-funded programs
Columbia River System	Same as existing conditions	Same as Alternative 1. If reservoir drawdown occurs, increased sediment and turbidity over the short term	Same as Alternative 2
Fisheries Resources: Threatened and Endangered Species (spring-run chinook, steelhead, and bull trout)			
Juvenile Migration/Survival Standards	Project specific standards, no specific protection measures for threatened or endangered species **Wells Dam**: Provide a non-turbine passage route (juvenile bypass system) to pass at least 80% of spring-run outmigrants and 70% of summer outmigrants **Rocky Reach Dam:** Provide safe (less than 2 percent mortality) non-turbine passage route (juvenile bypass or spillway passage) for 80% of juvenile migrants over 90% of the migration period	As required to recover the listed species	No Net Impact - 91% overall fish passage survival (juvenile and adult) with an independent standard of 95% juvenile survival through the forebay, dam and tailrace. Compensation to obtain no net impact also includes 7% to hatchery programs and 2% to tributary programs

TABLE 2-8. ENVIRONMENTAL COMPARISONS OF THE ALTERNATIVES (PAGE 2 OF 8)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Juvenile Migration/Survival Standards (continued)	**Rock Island Dam:** Fund an account to purchase spill at the requested by fish agencies and Tribes to an annual revenue loss of $2.05 million		
Adult Migration/ Survival Standards	Maintain and operate fishladders according to criteria established by the fishery agencies	As required to recover the listed species	No Net Impact - 91% overall fish passage survival (juvenile and adult) with an independent standard of 95% juvenile survival through the forebay, dam and tailrace. Compensation to obtain no net impact also includes 7% to hatchery programs and 2% to tributary programs
Hatchery Production	Hatchery for initial loss of habitat when dams were constructed would continue over the long term. Hatchery funding for unavoidable continuing losses from fish passage would be refined and based on ongoing survival studies	Same as Alternative 1, provided there are no impacts to listed species	Same as Alternative 1, except the production levels would be based on compensating for 7% of unavoidable project passage mortality. Exact amounts of fish produced are based upon the actual numbers of returning adults. Hatchery production would not be less than that specified to address project inundation
Tributary Habitat Improvements	Habitat improvements would occur through the implementation of non-PUD funded projects through Federal, State and local agency funding	Same as Alternative 1, although programs may be proposed in lieu of non-power measures if necessary to prevent the extinction of listed species	Same as Alternative 1 and additional funding provided through the HCPs to compensate for 2% of the unavoidable project mortality
Monitoring	At Wells, run timing and system efficiency monitoring would occur. At Rocky Reach and Rock Island, only monitoring to ensure facility modifications are achieving criteria identified in license articles, settlements, and stipulations	Survival studies for Endangered Species Act- listed juveniles and adults, total dissolved gas monitoring, facility evaluations and modifications	Studies necessary to ensure standards are being met for all species during phase I, periodic monitoring to ensure standards continue to be met during phase III
Drawdown	Drawdown can not be required under existing licenses	Drawdown is expected to increase survival rates of migrating juvenile fish over the long-term. However, lower water levels could initially increase predator density and predator/prey encounters. Over the short term, drawdown would decrease water quality, fish habitat, and foraging opportunities; and likely affect survival rates. Only an option at relicensing	Same as Alternative 2, although could be implemented by the PUDs anytime during the term of the agreement

TABLE 2-8. ENVIRONMENTAL COMPARISONS OF THE ALTERNATIVES (PAGE 3 OF 8)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Bull trout	Bull trout could benefit from dam protection measures and tributary habitat improvements but no studies have been conducted to date to confirm effects of existing project operations	Same as Alternative 1	Same as Alternative 1
QAR RESULTS	Based on run reconstructions from the late 1970s through the mid 1990s, the return rates for upper Columbia River spring-run chinook salmon have been trending down at a loss rate of 5 to 10 percent per year. Although complicated by hatchery influences, wild steelhead return rates on the Wenatchee and Entiat Rivers are comparable to those identified for spring-run chinook salmon, but are trending downward at a faster rate on the Methow	Although maximizing survival at each of the PUD dams will increase the return rates of spring-run chinook salmon and steelhead, populations will continue to decline without reductions in non-hydro system related impacts, although at a slower rate than Alternative 1. Under the best case scenario, (i.e., maximizing survival through the hydro system [to levels at or above those defined in the HCPs] with high survival during the ocean life stages of salmon and steelhead) the risk of extinction would be reduced to acceptable levels	Achieving the project survival and habitat improvement standards identified in the proposed HCPs will increase Mid-Columbia River reach survival by approximately 22-35 percent for steelhead and 27-45 percent for spring-run chinook salmon. Under these survival rates, populations will continue to decline without reductions in non-hydro system related impacts. Commitments to habitat productivity, in addition to dam passage survival increases, will increase survival rates by approximately 6-10 percent over Alternative 2. Under the best case scenario, achieving the survival standards in the HCPs alone would reduce the risk of extinction to acceptable levels. (The effects of long-term supplementation have not been analyzed.)
<u>Fisheries Resources: Other Plan Species (summer and fall chinook sockeye, and coho)</u>			
Juvenile Migration/Survival	Same as discussed for threatened and endangered species above	Same as Alternative 1	Same as discussed for threatened and endangered species
Adult Migration/Survival	Same as discussed for threatened and endangered species above	Same as Alternative 1	Same as discussed for threatened and endangered species
Adult Reservoir Spawning	Same as discussed for threatened and endangered species above	Same as Alternative 1, unless reservoir drawdown occurs	Same as Alternative 2
Hatchery Production	Same as discussed for threatened and endangered species above	Same as Alternative 1	Same as discussed for threatened and endangered species

TABLE 2-8. ENVIRONMENTAL COMPARISONS OF THE ALTERNATIVES (PAGE 4 OF 8)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Tributary Habitat Improvements	Habitat improvements would occur through the implementation of non-PUD funded projects through Federal, State and local agency funding	Same as Alternative 1	Same as Alternative 1 and additional funding provided through the HCPs to compensate for 2% of the unavoidable project mortality
Monitoring	Same as discussed for threatened and endangered species above	Same as Alternative 1	Survival studies would occur for all Plan species
Drawdown	Drawdown not proposed	Drawdown would increase spawning opportunities for fall chinook and increase migrating juvenile salmonid survival rates over the long term. However, lower water levels could increase predator density and predator/prey encounters. Over the short term, the resulting decreased water quality would affect fish habitat and foraging opportunities which would likely affect survival rates	Same as Alternative 2
<u>Water Quantity</u>			
Project Area Flows	No change in flows	Amount of spill could increase if necessary to prevent the extinction of listed species	Amount of spill could change dependent on efficiency of juvenile bypass systems and/or meeting the survival standards. However, water quantities would not be substantially altered
Reservoir Drawdown	Drawdown not proposed	Drawdown would increase water velocity	Same as Alternative 2
Tributary Flows	No effect	Same as Alternative 1, unless off site measures occurred to prevent the extinction of listed species	Same as Alternative 2, although additional funding would likely provide for more water conservation projects and more improvements in tributary flows
Columbia River System	No changes expected over existing conditions	Same as Alternative 1	Same as Alternative 1

TABLE 2-8. ENVIRONMENTAL COMPARISONS OF THE ALTERNATIVES (PAGE 5 OF 8)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
<u>**Water Quality**</u>			
Project Area Total Dissolved Gas	Some improvement expected as the Washington Department of Ecology (WDOE) imposes total maximum daily load limits for Clean Water Act compliance and other measures (e.g., spill deflectors) are implemented	Same as Alternative 1 although spill could increase if needed to prevent the extinction of listed species	Same as Alternative 1, although spill could increase as needed to meet survival standards resulting in an increase in total dissolved gas levels. However, the PUDs agreed to take measures to maintaining total gas levels at or below legal maximum levels
Tributary Water Quality	There is potential for incremental water quality improvements (e.g., higher dissolved oxygen, lower turbidity and sedimentation) as total maximum daily load program and other ongoing watershed restoration efforts proceed, and benefits from improved riparian protections are seen (no change from existing conditions)	Same as Alternative 1, although if proposed in lieu of non-power operations to prevent the extinction of listed species, restoration projects may improve tributary water quality	Same as Alternative 1, although guaranteed PUD funding would provide for more restoration projects and improvements in tributary water quality
Columbia River System Total Dissolved Gas	May be some marginal reduction in downstream total dissolved gas levels with improvements in project area total dissolved gas	Same as Alternative 1	Same as Alternative 1
<u>**Vegetation**</u>			
Project Area	No change from existing conditions	Same as Alternative 1. If reservoir drawdown occurs, it could impact shoreline and aquatic vegetation. One threatened plant species (giant hellborine) could potentially be affected by a drawdown and may require additional Endangered Species Act consultation	Same as Alternative 2
Associated Tributaries	Local and State fish habitat improvement projects are expected to improve riparian vegetation – no change from existing conditions	Same as Alternative 1	Same as Alternative 1, and HCP funding for tributary improvements would potentially benefit vegetation by removing invasive non-native plant species, adding or enhancing soils, and establishing buffer areas along tributary streams
Columbia River System	No change from existing conditions	Same as Alternative 1	Same as Alternative 1

TABLE 2-8. ENVIRONMENTAL COMPARISONS OF THE ALTERNATIVES (PAGE 6 OF 8)

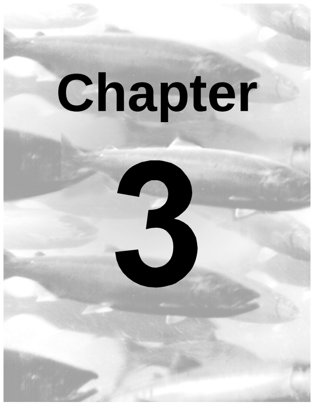
	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
<u>Wildlife</u>			
Threatened and Endangered Species	**Dams:** No change from existing conditions	**Dams:** No effect anticipated. If drawdown occurs, bald eagle abundance may decline due to declines in waterfowl prey	**Dams:** Same as Alternative 2
	Tributaries: Possible short-term disturbance to bald eagles from tributary habitat improvement projects conducted by other agencies. Possible benefits to bald eagles if projects improve riparian habitat and waterfowl prey base	**Tributaries:** Same as Alternative 1	**Tributaries:** Same as Alternative 1. HCP funding for tributary improvements could enhance habitat
	No effects on northern spotted owls, gray wolves, or grizzly bears		
	No change from existing conditions		
	Columbia River System: No effect	**Columbia River System:** Same as Alternative 1	**Columbia River System:** Same as Alternative 1
Other Wildlife	**Dams:** Possible decline in gull abundance. No effect to other wildlife. No change from existing conditions	**Dams:** Same as Alternative 1. If drawdown occurs, declines in abundance of waterfowl, aquatic furbearers, amphibians, and other riparian-associated wildlife may result	**Dams:** Same as Alternative 2. In addition, HCP funding for tributary improvements could enhance habitat
	Tributaries: Possible short-term disturbance to wildlife from tributary habitat improvement projects conducted by other agencies. Possible benefits to waterfowl, aquatic furbearers, and other riparian associated wildlife, if projects improve riparian habitat	**Tributaries:** Same as Alternative 1	**Tributaries:** Same effects from PUD and other agency habitat improvement projects as Alternatives 1 and 2
	Columbia River System: No effect	**Columbia River System:** Same as Alternative 1	**Columbia River System:** Same as Alternative 1
<u>Land Use</u>			
Project Area	No changes from existing conditions	May be modified if listed species are affected	The PUD will consider land use when implementing measures under the HCPs

TABLE 2-8. ENVIRONMENTAL COMPARISONS OF THE ALTERNATIVES (PAGE 7 OF 8)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Associated Tributaries	Local and State aquatic habitat enhancement projects may alter floodplains and result in land exchanges. Less development would be allowed at river shorelines. No change from existing conditions	Same as Alternative 1 unless the acquisition and conversion of existing land uses, such as agriculture commercial and residential to stream buffer habitat corridors, is necessary to prevent the extinction of listed species	Same as Alternative 2, although measures may result from actions taken for any of the plan species
Columbia River System	No change from existing conditions	Same as Alternative 1	Same as Alternative 1
Economics			
Project Area	No changes from existing conditions	Same as Alternative 1. If drawdown is proposed, a detailed economic analysis would be conducted	Same as Alternative 2
Tributary Habitat Improvement	Short-term local jobs in tributary habitat improvements. No change from existing conditions	Same as Alternative 1, If drawdown is proposed, a detailed economic analysis would be conducted	Same as Alternative 2 and Plan Species Account will provide some additional jobs and service related income
Columbia River System	No changes from existing conditions	Same as Alternative 1	Same as Alternative 1
Recreation			
Facility Operation and Maintenance	No changes from existing conditions	Same as Alternative 1. If drawdown occurs, reduced pool levels would make boat ramps and beaches unusable and substantially impact recreational facilities	Same as Alternative 2
Tributary Habitat Improvement	Short-term access may be affected as local and State aquatic habitat improvements occur. No change from existing conditions	Short-term access may be affected if tributary habitats were implemented to prevent the extinction of endangered species	Same as Alternative 2, although for all plan species. Same effects from PUD and other agency habitat improvement projects as Alternatives 1 and 2

TABLE 2-8. ENVIRONMENTAL COMPARISONS OF THE ALTERNATIVES (PAGE 8 OF 8)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Columbia River System	No changes from existing conditions	Same as Alternative 1. If drawdown occurs, increased fishing upstream and downstream of the projects may result	Same as Alternative 2
<u>Cultural Resources</u>			
Project Area	No change from existing conditions	Same as Alternative 1. If drawdown occurs, substantial impacts could occur to cultural resources	Same as Alternative 2
Tributaries	Tributary habitat improvements could affect some cultural resources unless surveys and mitigation (if needed) are conducted prior to earth moving activities. No change from existing conditions	Same as Alternative 1	Same as Alternative 1
Columbia River System	No change from existing conditions	No change would occur. If drawdown occurs, impacts could occur to cultural resources at downstream dams	Same as Alternative 2



Chapter 3

Affected Environment

Chapter

3 AFFECTED ENVIRONMENT

This chapter summarizes the environmental resources within the Mid-Columbia River region, including the upland areas adjacent to the mainstem Columbia River and the four major tributaries. The purpose of the chapter is to document both the existing conditions and the current effects that Mid-Columbia River hydroelectric project operations have on these resources. This information will be used in Chapter 4 to assess the effects of project operations under the alternatives addressed in this EIS.

The specific resources discussed in this chapter include land features/geology/soils, fisheries resources, water resources (quantity and quality), vegetation, wildlife, land ownership and use, recreation, and cultural resources.

3.1 LAND FEATURES, GEOLOGY, AND SOILS

Key Terms

Basalt – A fine-grained, igneous rock dominated by dark-colored minerals. Cliffs along the Columbia River Valley are typically formed in basalt.

Channel Structure – Channel structure is formed by river bed roughness elements like bars and bends, in channel logs or debris jams, bank vegetation, and large rocks. Channel structure is important for channel flow velocities, aquatic habitat, and can help to prevent channel erosion.

Columbia Plateau – Relatively flat region of eastern Washington and Northern Oregon formed by vast accumulations of near horizontal flows of basalt lava.

Fluvial – Related to rivers, produced by river action like a fluvial plain or river bar.

Geomorphology – Branch of geology that deals with the form of the earth and earth surface and the changes that take place in river and hillside landforms.

Glacial – Related to or formed by a glacier. Extensive glaciers flowed into the Mid-Columbia River area greatly influencing the river and valley landforms and geologic deposits.

Gneiss – Coarse grained, metamorphic rock in which bands of differing mineral composition and texture appear.

Graben – An elongate, trench like structural form bounded by parallel faults, created when the block that forms the valley floor moved downward relative to the blocks that form the valley wall sides.

Headwater Elevation – The average or maximum reservoir elevation at the project dam.

Physiographic Regions – Areas with similar landforms, geologic materials, soils, and climate.

River Terrace – Relatively flat areas formed by the rivers. Terraces near the rivers are active floodplains; higher terraces have been abandoned by river down-cutting and are no longer accessed by flood flows. Floodplain terraces are common locations for wetlands and side channels, and are important areas for storage of floodwaters, and aquatic and wildlife habitat.

Schist – Medium or coarse grained, metamorphic rock dominated by subparallel orientation of platy mica minerals.

Sediment – Clay, silt, sand, gravel and cobbles that are deposited into layers by wind, ice, water, or gravity.

Structural Depression – Valley area formed by geologic faulting.

Tailwater Elevation – The average or minimum water elevation at the toe of the dam.

** See Chapter 6 for a complete listing of all Key Terms.*

3.1.1 LAND FEATURES

3.1.1.1 Project Area

The three project area dams are located in the Columbia River valley between the Columbia plateau and the Cascade mountains. Watersheds to the west and north of the project areas include mountain streams flowing from the Wenatchee mountains, the Chiwaukum and Methow structural depressions, the north Cascade mountains, and the Okanogan highlands. The watersheds to the east of the project areas are on the Waterville plateau, which is the northeast portion of the much larger Columbia plateau (Figure 3-1).

The associated tributary watersheds contributing to the project area include a broad range of terrain types, geologic materials, and climate regions; high elevation mountain peaks with glaciers to flat 3-mile wide valley bottoms. Conditions vary from desert and steppe conditions in the eastern parts of the project watersheds, with as little as 7 inches of annual rainfall, to the snow covered north Cascade mountains to the west, with over 100 inches of precipitation annually.

Wells Dam

The Wells Dam, located at river mile 515.8, is the furthest upstream dam in the project area. The Wells Dam, constructed between 1963 and 1967, is the most recent to be built on the Mid-Columbia River mainstem. The dam has a central reinforced concrete structure 1,130 feet long with earth and rock fill embankments on both sides. The east embankment is 1,030 feet long and the west embankment is 2,300 feet long, for a total embankment length of 3,320 feet. The Wells Dam is the only hydrocombine (combined powerhouse and spillway structure) on the Columbia River.

The valley floor is about 4,000 feet wide at the Wells Dam. The original river channel was about 700 feet wide against the east (left bank) valley wall (Galster 1989b). The east side of the valley (left bank) consists of a series of narrow terraces. The west side (right bank) consists of a terrace at 720 feet elevation that is about 2,000 feet wide followed by a 2,000 foot wide terrace going from 750 to 775 feet elevation where it meets a steep bedrock face that serves as the west abutment for the dam. The valley bottom continues with another glacial age terrace at an elevation of 880 feet and another at 1,200 feet elevation that meets the bedrock west valley wall.

The Wells reservoir extends from river mile 515.8 to the tailrace of Chief Joseph Dam at about river mile 545.5. The reservoir has an area of 9,740 acres and is between 1,300 and 8,000 feet wide, with an average width 2,700 feet. The reservoir contains a total storage volume of 331,000 acre-feet. The normal reservoir elevation is 781 feet with a tailwater elevation of 703 feet. The dam has 10 units operating with a hydraulic head of 67 feet.

Rocky Reach Dam

The Rocky Reach Dam is located at river mile 474.5. The dam and original powerhouse with seven power units were constructed between 1956 and 1961. Four additional power units were added between 1969 and 1971. The Rocky Reach Dam is a Z-shaped structure with a spillway, powerhouse, and service bay. The dam is essentially a gravity structure that rises 218 feet above the lowest bedrock support at 499 feet elevation (Coombs 1989). The length of the concrete dam is 2,860 feet and the cut-off structure on the left bank 2,860 feet long.

The valley bottom is about 5,000 feet wide at the dam site. The site consists of a left bank terrace, 140 feet above the river at low flows, that extends for 3,500 feet from the river to the valley wall cliffs (Coombs 1989). The dam rests on rock of the former channel that was about 1,000 feet wide at high flows. The west (right bank) side of the dam is against the valley wall which has shallow soil materials over bedrock.

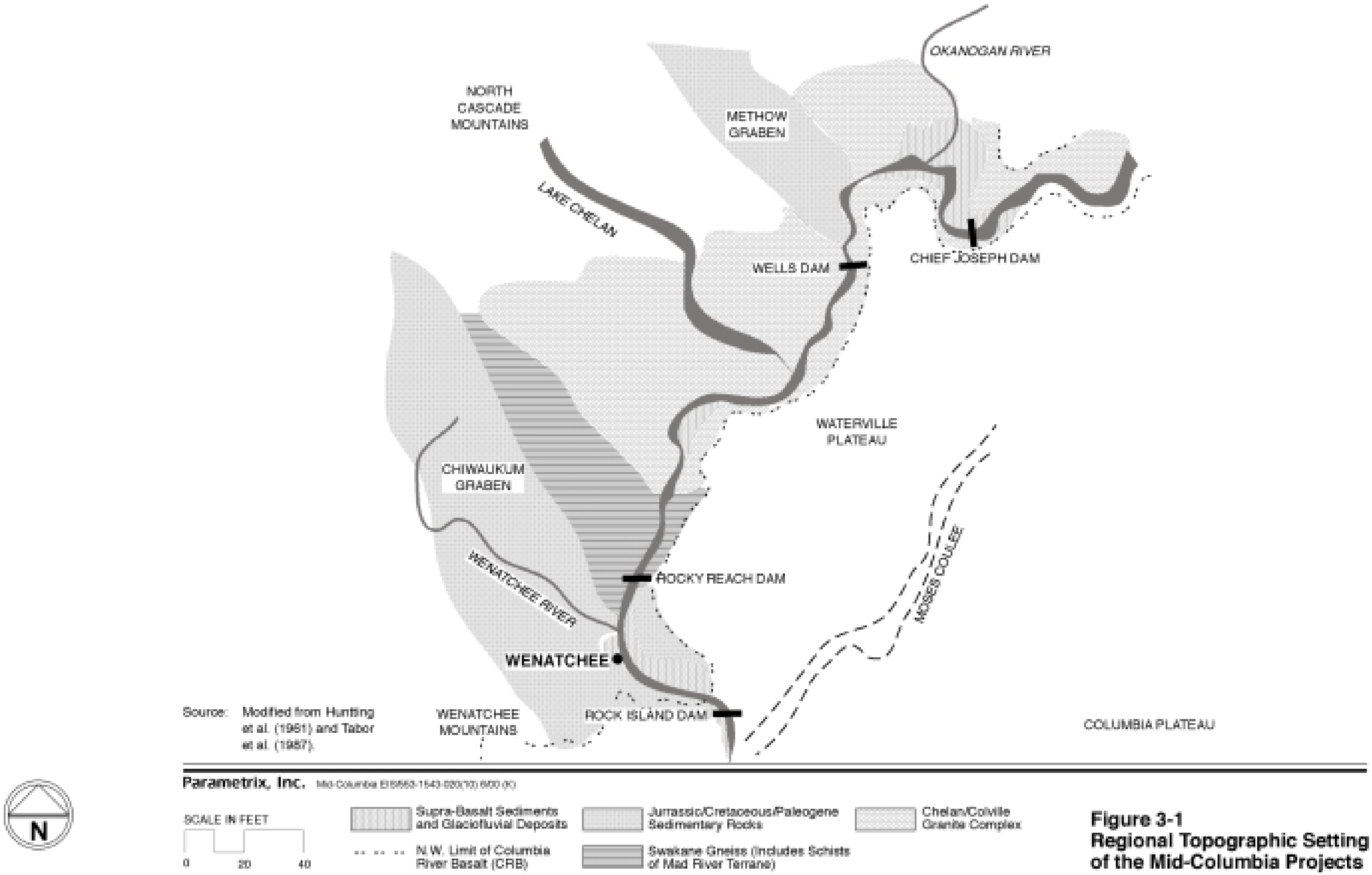


Figure 3-1
Regional Topographic Setting of the Mid-Columbia Projects

The Rocky Reach reservoir extends from river mile 474.5 to the Wells Dam tailrace at about river mile 516. The reservoir has an area of 9,100 acres with a width of 1,500 feet to over 5,000 feet. The reservoir contains a total storage volume of 412,000 acre-feet with 35,000 acre-feet of usable water storage at 4 feet of drawdown. The average project headwater elevation is 706.5 feet with an average tailwater elevation of 617.5.

Rock Island Dam

The Rock Island Dam, located at river mile 453.4, is the furthest downstream dam in the project area. The dam, powerhouse, and first four turbine units were constructed between 1930 and 1933. The Rock Island Dam was the first dam to be built on the Columbia River main stem. Additional work continued on the powerhouse and six additional turbine units were constructed between 1951 and 1953. A second powerhouse with eight turbine units was built between 1974 and 1979. Rock Island Dam is a reinforced concrete structure 3,600 feet long with a deck-top elevation of 616 feet and a total hydraulic head of 36 feet.

The valley bottom is about 7,000 feet wide at the dam site. Original selection of the site was based on the availability of shallow bedrock at one of the five major Columbia River rapids: Rock Island rapids (Galster 1989a). The Rock Island rapids were formed by a flat-topped mass of basalt called Rock Island. Part of this island is still visible at the dam site. The rapids were positioned against the east (left bank) side of the valley due to the deposition of a large glacial age terrace on the west side of the valley. At low flows, the Columbia River channel was originally 200 feet wide on either side of Rock Island; at flood flows the entire dam site area was underwater.

The Rock Island reservoir extends from river mile 454 upstream to the Rocky Reach tailrace at about river mile 474. The reservoir is 3,300 acres in area with a typical width of 1,500 feet. The reservoir has a total storage volume of 130,000 acre-feet with 12,480 acre-feet of usable storage at 4 feet of drawdown. The normal project pool elevation is 612.6 feet with an average tailwater elevation of 573.2 feet.

3.1.1.2 Associated Tributaries

The main tributary watersheds can be divided into three typical physiographic regions that have a similar range of landforms, geologic materials, soils, and river processes: (1) the mountainous regions of the western and northern tributaries, (2) the valley bottom areas in the lower portions of the tributaries, and (3) the Columbia plateau region east of the Columbia River valley.

The tributaries originate in the high Cascade mountains of the U.S. and Canada. Major tributary rivers in this physiographic region include the upper portions of the Wenatchee, Entiat, Methow, and Okanogan rivers. Climatic conditions range from extreme alpine and subalpine in the upper basins to wet and dry forests in the foothills. Precipitation ranges from 25 inches to over 140 inches per year in the upper Wenatchee basin, from 35 to 80 inches per year in the upper Entiat basin, from 15 to 80 inches per year in the Methow basin, and from 30 to 40 inches per year in the upper Okanogan basin. Snowmelt and rainfall run-off from this region is a major source of water for hydroelectric power, irrigation, and instream flows. The mountain areas are characterized by steep hillslopes with very high to moderate gradient tributary creeks. Limited flat areas occur along the valley bottoms, on ancient and recent river terraces, and floodways.

The second typical physiographic zone, the valley bottoms, is in the lower portions of the western and northern tributary valleys where glaciers and the tributary rivers have eroded deep, relatively wide valleys. Climate, soil, and vegetation conditions include dry forests, grass steppe, and shrub steppe. Precipitation in the lower tributary valleys ranges from 7 to 15 inches per year. This area is characterized by steep rolling hills along the valley walls with flat to moderate slopes on ancient terraces and along the valley bottoms. Stream gradients are from high to moderate in the lower valleys.

The third main physiographic zone, the Waterville plateau, includes the plateau and tributary streams east of the Columbia River valley and the area southwest of Omak Lake. The main tributaries from this region include Omak, Douglas, and Rock Island creeks. Climate, soil, and vegetation conditions include grass steppe, shrub steppe, and desert. Average precipitation is 10 inches per year. Tributary flows are considerably less from the Waterville plateau compared to the run-off from the Cascades.

Wenatchee River Valley

The Wenatchee River enters the Columbia River at river mile 468.2, about 15 miles upstream of the Rock Island Dam and 6 miles downstream of the Rocky Reach Dam (see Figure 1-2). Its watershed covers an area of 1,328 square miles. The river itself begins at Lake Wenatchee in the Cascade mountains. The Wenatchee mountains form the southern portion of the watershed, the north Cascade mountains form the western portion, and the Entiat mountains form the northern portion of the watershed. Elevations range from 615 feet at the river mouth to just over 8,500 feet at the highest upper watershed peaks.

Entiat River Valley

The Entiat River enters the Columbia River at river mile 484, about 10 miles upstream of the Rocky Reach Dam (see Figure 1-2). With a watershed area of 419 square miles, this is the smallest watershed of the four main tributaries. The south side of the basin is formed by the Entiat mountains. The Chelan mountains form the northern portion of the watershed and the north Cascade mountains form the western portions. Elevations range from 708 feet at the river mouth to just over 9,000 feet at the highest upper watershed peaks.

Methow River Valley

The Methow River enters the Columbia River at river mile 523.9, about 7 miles upstream of the Wells Dam (see Figure 1-2). The Methow River has a watershed area of 1,791 square miles. Sawtooth Ridge marks the southwest side of the basin. The northern portions are in the Pasayten Wilderness and the north Cascade mountains form the western portions of the basin. Elevations range from 780 feet at the river mouth to just over 8,000 feet at the highest upper watershed peaks.

Okanogan River Valley

The Okanogan River begins near Armstrong, British Columbia and flows south through a series of lakes to the Columbia River where it enters the Columbia River at river mile 533.5, about 17 miles upstream of the Wells Dam (see Figure 1-2). The Okanogan watershed covers an area of about 8,200 square miles, 2,342 square miles of which occur in the United States. The northern portion of the watershed is in the Okanogan highlands of the U.S. and Canada. The southern part of the basin near the river mouth is in the northwest corner of the Columbia plateau. Elevations range from 780 feet at the river mouth to over 8,400 feet at the highest upper watershed peaks.

3.1.1.3 Columbia River System

The Columbia River has a watershed area of 259,00 square miles, with 39,000 square miles in Canada. The Columbia basin includes physiographic provinces in both the U.S. and British Columbia including parts of the Pacific border, Cascade range, Columbia plateau, northern Rocky mountains, and the middle Rocky mountains (U.S. Geological Survey [USGS] 1994). The overall watershed is bounded by the Rocky mountains on the east and the Cascade and Coast ranges on the west. The basin includes 100,000 square miles of the Columbia plateau. The Columbia River is about 1,243 miles long, with 91 miles located within the project area.

The project dams and the main Mid-Columbia River tributaries are located in the rain shadow of the Cascade range with arid to semi-arid climates, low precipitation, dry summers with warm to hot temperatures and cold winters. Average precipitation in the entire Columbia River basin is less than 20 inches annually with much of this occurring in the winter. Some marine influences occur in the alpine zones of the Cascades where as much as 40 to 140 inches of precipitation occurs, mostly as snow. Higher precipitation amounts (40 to 100 inches/year) also occur in the lower river from the Pacific Ocean to the Columbia Gorge, because of the marine influence; and in the mountain ranges of Idaho and Montana, because of elevation.

Major dams in the Columbia River basin (with active water storage over 5,000 acre-feet) include 20 in Montana, 48 in Idaho, 33 in Washington, 45 in Oregon, and 16 in Canada (USGS 1994).

3.1.2 GEOLOGY AND GEOMORPHOLOGY

Under the Federal Power Act, hydroelectric projects are reviewed and inspected by FERC staff and contractors to confirm that project structures are stable and safe, and whether geologic hazards may threaten the facilities or public safety. These inspections are ongoing, and include (when needed) sampling and analysis for seismic hazards, spillway capacity, landslide potential, and erosion issues.

3.1.2.1 Project Area

The Cascade mountains and Okanogan highlands to the west and north of the project area include a mix of granitic, volcanic, metamorphic and sedimentary rocks that have been added onto the North American continent by plate tectonic motions and deposition of material eroded from uplifted areas. Great regional ice sheets and local alpine glaciers modified the mountain areas and tributary valleys. Glacial and alluvial deposits fill the valley with up to several hundred feet of sediment forming extensive terraces along the valley edges. Sediment transported from the mountains and reworked from the valley fills form the current floodway and channel deposits along the river valley bottoms.

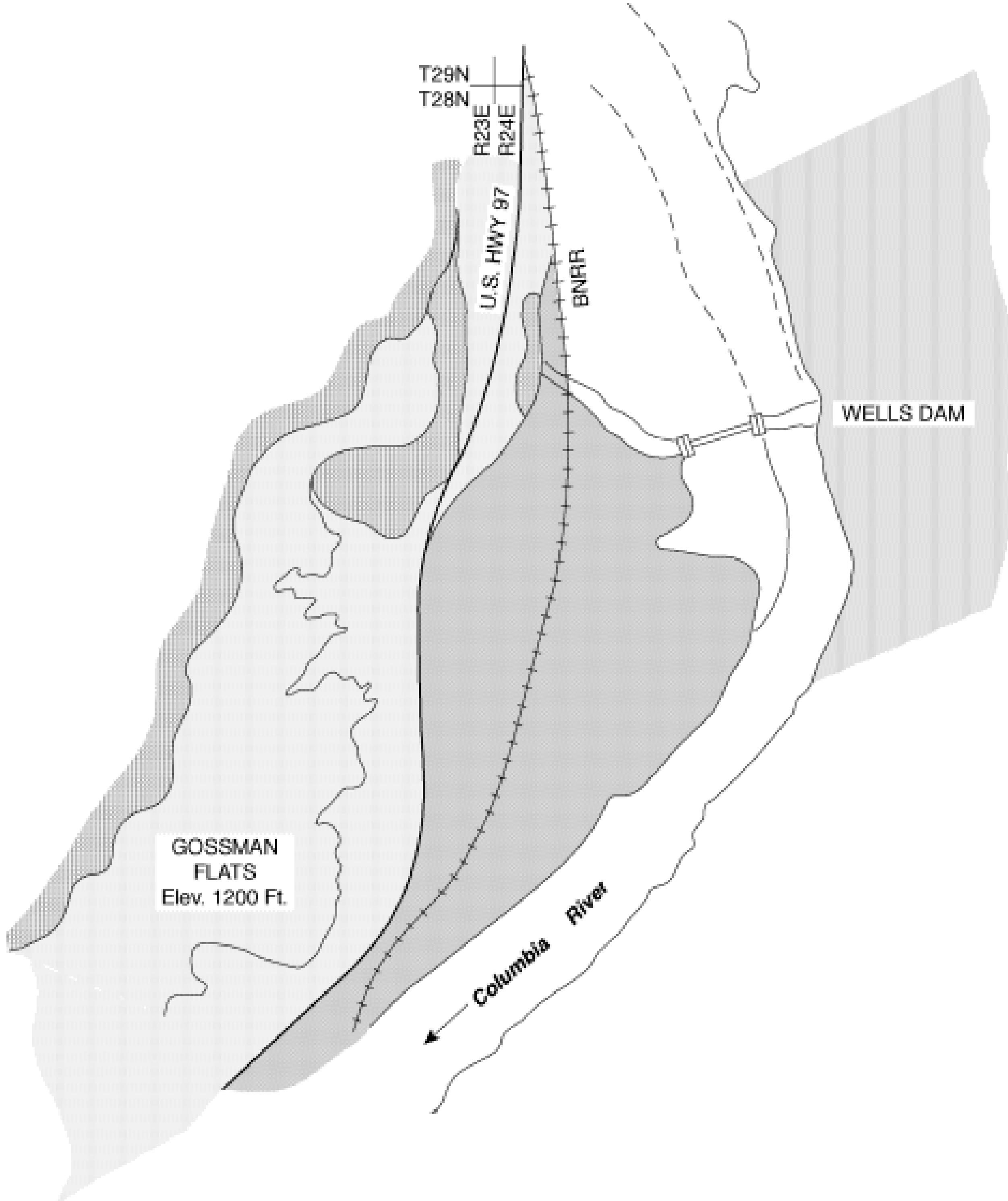
The project area dams are in a portion of the Mid-Columbia River that can be divided into three basic geologic segments. Between the mouth of the Okanogan River and the Wenatchee River, the Columbia River runs in a deep, steep-walled valley cut into the granitic and gneissic rocks of the northeastern Cascades. Two of the project dams and reservoirs, Rocky Reach and Wells, are within this segment of the Mid-Columbia River. The Okanogan, Methow and Entiat valleys are also in this geologic region.

The second geologic segment runs for several miles downstream from the Wenatchee River; softer sedimentary rocks of the Chiwaukum graben underlay it. Most of the rocks in the Wenatchee River basin are in the same sedimentary rocks, the Chumstick formation.

The third geologic segment along the Mid-Columbia River begins about 5 miles downstream of the Wenatchee River where the river approaches the north side of the Wenatchee mountain uplift. Here the river is deflected about 10 miles eastward onto the lava plateau underlain by the Columbia River basalts. The river has cut a 600-foot deep canyon into the Columbia plateau basalts. Rock Island Dam is in this portion of the Mid-Columbia River.

Wells Dam

The Wells Dam site was selected because of the presence of bedrock on either side of the valley about midway between the downstream Rocky Reach project and the upstream Chief Joseph Dam. Prior to construction, the river channel was 700 feet wide located against the east valley wall (Figure 3-2) (Tabor et al. 1982; Galster 1989b). The floodplain west of the river is about 1,000 feet wide.



Source: Galster, 1989.

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SCALE IN FEET
0 1000 2000

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Fluvial Deposits

Glacial Fill Terrace Deposits

Granite Bedrock

Scattered Bedrock Exposures with Colluviam and Glacial Terrace Remnants

Figure 3-2
Geology of the Wells Dam Area

Additional ancient terraces of glacial, alluvial, and lake deposits occur on the west side of the valley. Bedrock beneath the ancient west bank terraces is about 200 feet lower than the historic river channel. The east side of the valley rises sharply in a series of glacial and fluvial terraces backed by granitic rock slopes that are capped by the basalt beds of the Waterville plateau, 2,000 feet above the valley floor. The east side of the dam is an embankment 1,000 feet long with underlying glacial and alluvial sediments on granitic bedrock. The west side of the dam is an embankment 2,300 feet long with underlying layers of glacial and alluvial sediments as thick as 200 feet to granitic bedrock. The dam (spillway, powerhouse, and fishladders) is built on granitic bedrock cut by north trending basic igneous dikes (Galster 1989b).

The dam site and reservoir valley floor is underlain by a sequence of glacial and fluvial deposits consisting of gravel and sand with local cobble and boulder units, and silty sandy gravel, with lenses of fine sand and silt lake deposits (Galster 1989b). The construction of upstream dams, beginning in 1955 with Chief Joseph Dam, cut off the main supply of upstream bedload sediment into the Wells reservoir. The main source of sediment into the reservoir is now from the tributaries, the greatest majority coming from the Methow and Okanogan rivers. Sand and gravel deposits occur near the mouths of each tributary, with silt and sand being deposited in the reservoir further away from the tributary inputs.

Rocky Reach Dam

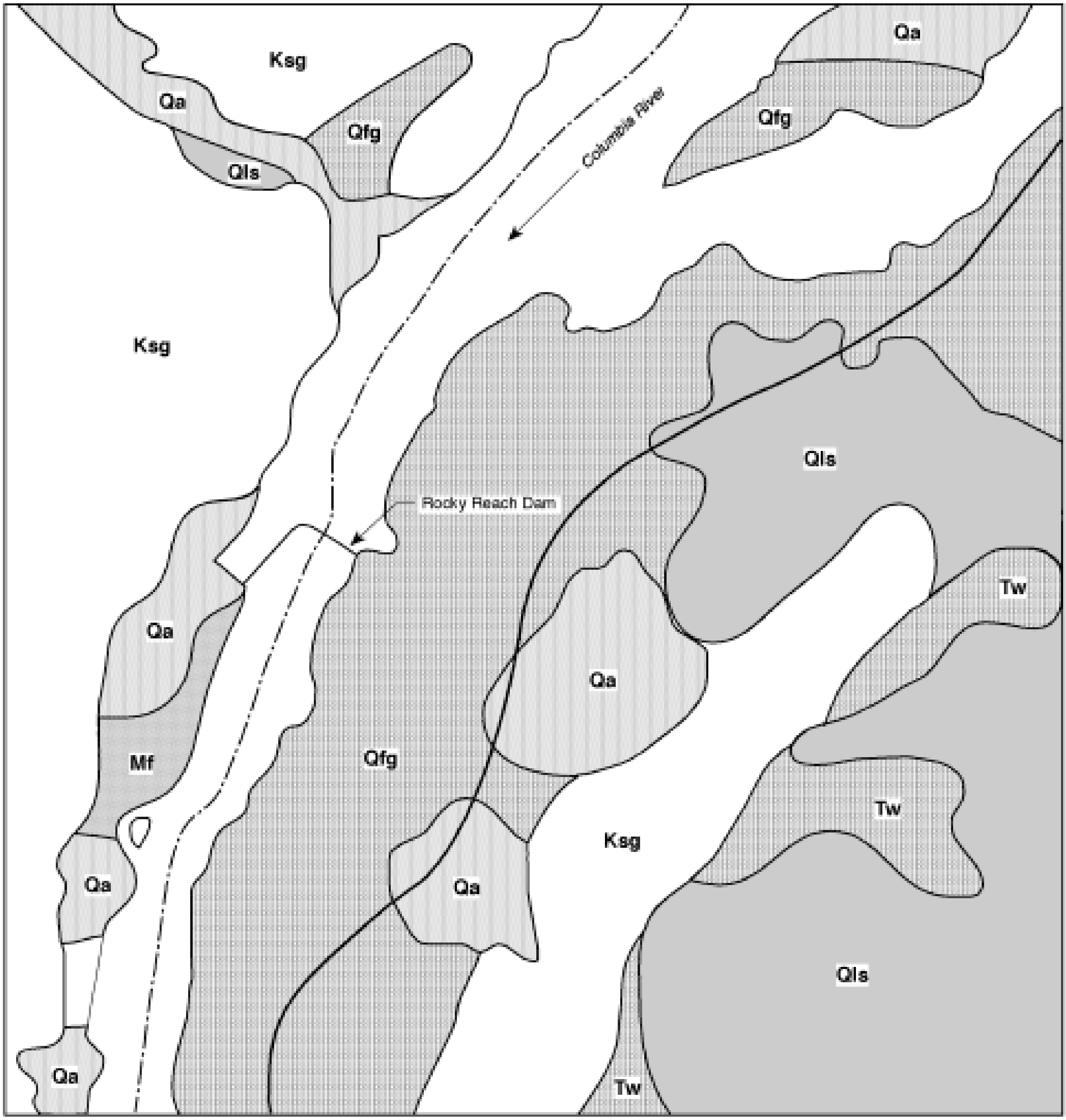
The mountains to the north, the west, and the bedrock under the Rocky Reach Dam are all in the Swakane biotite gneiss (Figure 3-3) (Waters 1932; Tabor et al. 1987). On the east bank, the Swakane gneiss forms a cliff 2,000 feet above the river that is capped by the Columbia River basalts at the western edge of the Columbia plateau (Coombs 1989). An east bank terrace surface 140 feet above the low flow river extends 3,500 feet from the rivers edge to the valley wall cliff (see Figure 3-3). Exploration during construction revealed a thin layer of sediments over bedrock in the river bottom at the historic river channel location. Beneath the large terrace on the east bank, the bedrock surface is 130 feet lower than beneath the historic channel location. The terrace consists of a layer of coarse gravels from a few feet to more than 100 feet thick, directly overlying the bedrock. Above the gravels is a varved (thin bedded) lake bottom clay 180 feet thick. In some locations the clay unit has been eroded away by the river. Above the clay layer are river laid sands and gravel.

The supply of upstream bedload sediment into the Rocky Reach reservoir was cut off 5 years after completion of the dam, following the construction of the Wells Dam. The main source of sediment into the reservoir is now the Entiat and Methow rivers. Sand and gravel deposits occur near the mouths of each tributary with silt and sand being deposited in the reservoir further away from the tributary inputs.

Rock Island Dam

At the site of the Rock Island Dam, anticlinal ridges of the Wenatchee mountains forced the Columbia River to the east where it cut into the generally flat lying Columbia River basalts. The original Rock Island rapids and Rock Island are positioned hard against the east side of the Columbia River valley due to deposition of extensive glaciofluvial deposits from glacial and great flood events (Galster 1989a) (Figure 3-4). The dam, powerhouse, and spillway are built on basalt and tuff bedrock.

The Columbia River valley was about 6,000 feet wide at the dam site and much wider upstream near Wenatchee prior to being filled with a several hundred feet of sand and gravel during the great Missoula floods. This forced the river onto higher bedrock on the east side of the valley, thus creating the Rock Island rapids. The great floods flowing out of Moses Coulee, deposited sediment both up and downstream. The flood deposits form a terrace to the west, upstream, and downstream along the river, consisting primarily of sand and gravel with



Source: Galster, 1989.

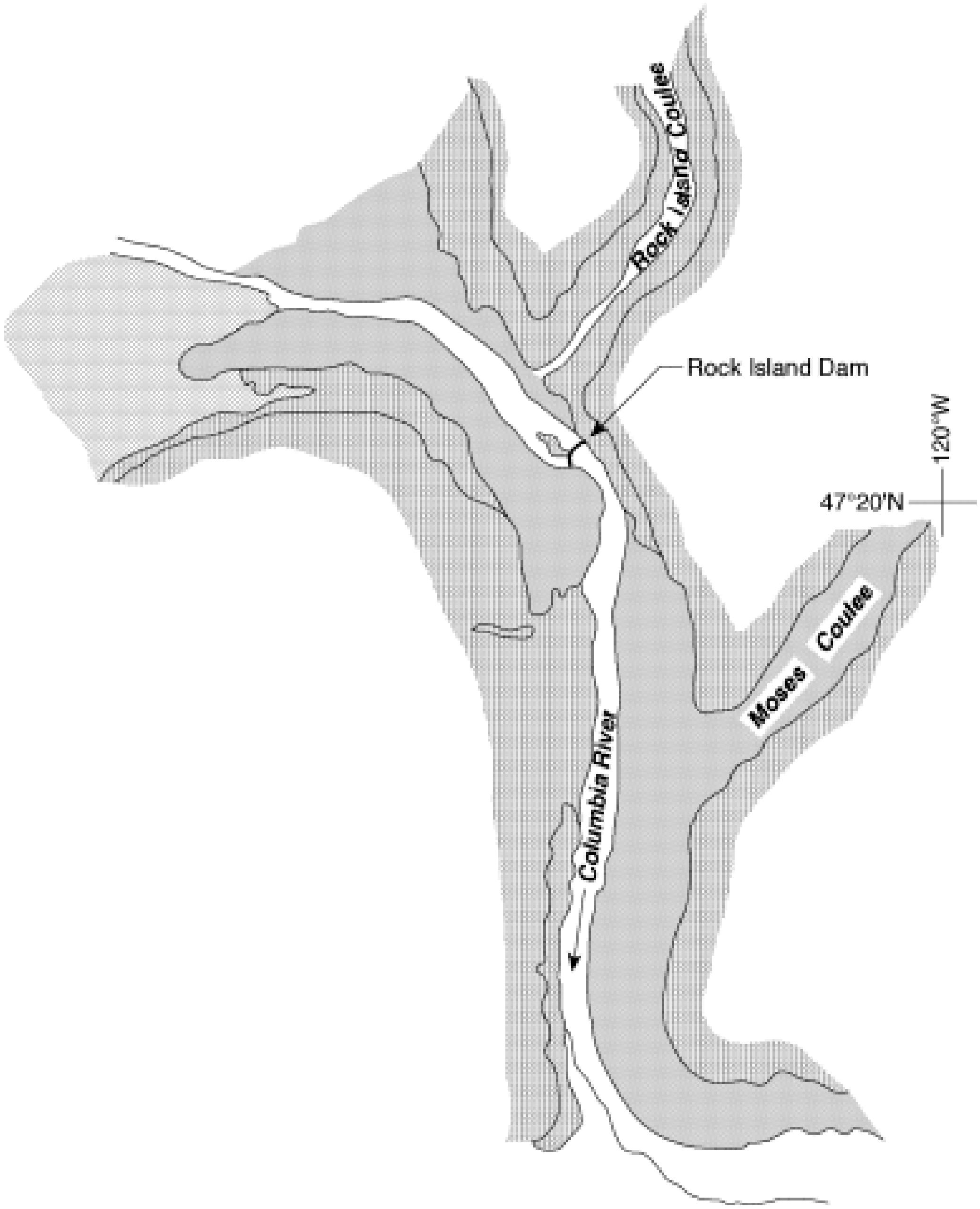
Parametrix, Inc. Mid Columbia/553-1543-020(10) 6/00 (K)

Mf	Fill	Tw	WenatcheeFormation
Qa	River Alluvium	Ksg	Swakane Gneiss
Qfg	Glacial Flood Deposits	Qls	Landslides

SCALE IN MILES
0 .75 1.5

N

Figure 3-3
Geology of the
Rocky Reach Dam Area



Source: Galster, 1989.

Parametrix, Inc. Mid Columbia/553-1543-020(10) 6/00 (K)

Figure 3-4
Geology of the Rock Island Dam Area

cobbles, boulders, and thin layers of silt and clay. The bedrock surface is deeper under the terrace than at the dam site. The terrace surface, over 200 feet above the riverbed, has numerous ice-rafted basalt blocks up to 20 feet in diameter.

The glacial and great flood deposits underlay the reservoir and form the reservoir and former Columbia channel banks. The river reworked these glacial deposits along the former floodway, forming sand and gravel alluvial deposits. Alluvial sediment, transported by the Columbia River prior to construction of the Rocky Reach Dam (29 years after the Rock Island Dam was constructed), deposited in the upper end of the Rock Island reservoir. Sand and gravel occur in the upstream portions of the reservoir with sand and silt being deposited in the downstream portions. Additional sediment is deposited in the reservoir in the form of a delta where the Wenatchee River enters the reservoir.

Suspended sediment transport in the Mid-Columbia River is relatively low (BPA et al.1994a). Each upstream reservoir allows a portion of the seasonally high suspended sediment loads, from the upper Columbia River, to settle out during transit. Direct input of fines from the tributaries is now the main source of silt and fine sand into the Rock Island reservoir. Typical water and suspended sediment travel rates through the Mid-Columbia River are between 1 to 4 feet per second at flows of 100,000 to 380,000 cfs respectively (NMFS et al. 1998b). This allows fine particles in the water column to settle at a higher rate than if natural current velocities occurred. The fine sediment deposits on the bottom where it is often reworked by slumping off the steep reservoir edges and by higher velocities that occur during extreme flood flows. This tends to move the deposited clay, silt, and fine sand into the deeper portions of the reservoir.

3.1.2.2 Associated Tributaries

The range of watershed and river channel conditions are quite similar for all of the main tributary rivers. The river channels in each of the tributaries receive sediment delivered by creeks, mass-wasting, and surface erosion. The steep mountain conditions and presence of glacial deposits result in high sediment delivery rates to the upland creeks. The high gradient mountain streams of the upper watersheds have a large and coarse textured bedload that is deposited onto alluvial fans and channel bars along the main river floodways. Additional channel sediment is eroded from the banks in natural channel migration and erosion of alluvial, glacial, or residual soils along the rivers.

Depending on flow conditions, a portion of the sediment that enters the creeks is transported downstream and a portion is stored along the channel in the channel bars, on the banks, and overbank on the floodplain. Fine sediment is derived from reworking of the glacial and valley bottom deposits by the creeks and from sheet wash erosion of bare areas in the watershed.

Vegetation (including standing and fallen trees) along with stream banks, brush, forbs, and grasses all play an important function to tributary channel conditions; they protect the banks and provide instream diversity that is important to aquatic and riparian habitat conditions. Depending on the land use and development history, various portions of the tributary creek and river channels have been modified from natural conditions by flood impacts, forest harvest, fires, transportation right-of-ways, and land modifications related to agricultural, residential, and urban development.

Wenatchee River

The Wenatchee River valley is formed in the softer sedimentary rocks of the Chumstick formation preserved in the structural basin referred to as the Chiwaukum graben (Cheney 1994). The Chumstick formation consists of folded shale, sandstone, and conglomerate. The Leavenworth fault zone is on the southeast boundary of the Chiwaukum graben. The metamorphic rocks of the Swakane gneiss are across the Entiat fault on the northeast side of the graben. Glaciation in the northern portion of the basin has resulted in a thick mantle of till overlying lower ridges and valley walls (U.S. Forest Service [USFS] 1999). The entire southern section of the watershed escaped glacial modification.

The Wenatchee River begins at Lake Wenatchee. The Little Wenatchee River and White River flow into the northwest end of the lake and numerous very high gradient mountain streams with falls, cascades, and step-pool channels flow from the steep valley walls around the lake. The lower White and Wenatchee rivers have a gradient of around 1 percent and are slightly entrenched in wide glacial valleys. Large woody debris and channel pool conditions are average. Sediment transport rates are high in the tributaries to Lake Wenatchee, especially during flood events. Most of the sediment delivered to the lake is deposited in the lake as deltas, alluvial fans, and lake bottom sediments.

Nason Creek and Chiwawa River join the Wenatchee River at the outlet of Lake Wenatchee (river mile 53.6). Nason Creek flows through a glacial formed canyon with a gradient of less than 1 percent in the lower portion. Some side channels have been cut-off by Highway 2 and over 5 percent of the lower channel has rip-rapped banks. The Chiwawa River is the largest Wenatchee River tributary. The river channel is dominated by riffle habitat, with pools primarily associated with log jams and meanders. The channel does not meet the USFS standards for large woody debris or pools (USFS 1992).

The Wenatchee River, from the lake to Chiwawa River, cuts through a glacial outwash plain with a pool-riffle channel composed mainly of cobble and gravel substrate. Large deep pools are relatively frequent. The Wenatchee River, from Chiwawa River to the Tumwater Canyon, is a pool-riffle and plane-bed channel with further entrenchment, increased gradient, and fewer pools compared to upstream areas. Substrate is also coarser than upstream areas, with more boulders and cobbles as a result of the steeper gradient and confinement of the channel.

Tumwater Canyon is a non-glaciated portion of the valley that the Wenatchee River passes through. Hillslopes are steep igneous and metamorphic rocks forming a deep, narrow, V-shaped valley. The channel is pool-riffle and step-pools with a gradient of less than 2 percent. Long deep pools alternate with steep riffles. Alluvial and debris fans form along the channel where very high gradient tributary creeks flow into the canyon. The channel in the canyon has been modified due to railroad, highway, and dam construction. Large bed elements and large woody debris sources were removed for historic log drives down the river, resulting in higher velocities, fewer pools, and reduced structure to the canyon channel.

Chiwaukum Creek joins the Wenatchee River at river mile 35.9. It is a pool-riffle channel at its mouth, a steep-pool channel in the middle reaches, and is dominated by cascades in the upper reaches. Large log jams and cobble/boulder substrate contribute to a stable channel condition. Loss of riparian vegetation has increased stream bank erosion.

Icicle Creek at river mile 25.6, and Chumstick Creek at river mile 35.9 join the Wenatchee River at the town of Leavenworth. Both creeks are unconfined low gradient streams. Icicle Creek has extensive bank rip-rap and a substantial amount of riparian vegetation has been removed (Chapman et al. 1994a). Side channels and oxbows of the original streamway have also been cut off from the main channel. Chumstick Creek has been straightened and realigned along much of the channel in the historical anadromous zone. It has a high percentage of silt in the lower 9 miles and is a major source of sediment to the Wenatchee River. Several culverts alter the channel conditions, including one that is a passage barrier at the river mouth.

In the upper Wenatchee River watershed, more than 2,500 miles of trails and 4,700 miles of roads provide access to the Wenatchee National Forest. Portions of these roads impact the creek and river channel conditions. Forest practice impacts are minor in Icicle Creek watershed, but are significant in the other tributary watersheds (NMFS et al. 1998b). Forest roads in the Peshastin and Chumstick watersheds are often located in the narrow floodplains of the creeks encroaching into the streamway, reducing riparian canopy, modifying rain and snowmelt run-off, and increasing fine sediment loads to the creeks; all of which have altered stream channel conditions. Fine sediment levels in the river substrate are above the USFS standard (20 percent) in Mission, Peshastin, and Tronsen creeks (NMFS et al. 1998b). Many of the harvest areas in these watersheds were cut prior to 1988 when no stream riparian buffers were required. At that time, fish-bearing streams had minimal buffers, which are now known to be inadequate for the full range of riparian zone functions.

Increased recreation along the White and Chiwawa watershed creeks has resulted in substantial amounts of wood harvest by campers and is likely occurring in other areas as well (NMFS et al. 1998b). This causes local bank erosion, loss of large woody debris, and channel sedimentation.

The wide lower gradient valley of the Wenatchee River begins at Leavenworth. A glacier from the Icicle Creek drainage deposited a moraine across the valley that filled and widened the valley behind it; resulting in a sinuous, unconfined, pool-riffle channel. The channel form would naturally be controlled by overbank flows and channel migration. This has been limited by rip-rapped banks to protect floodplain development. Flows are concentrated in the channel, causing channel incision and bed form changes.

The lower Wenatchee River was originally unconfined, meandering, and had considerable channel structure with extensive side channel areas. The relatively uniform channel is now moderately entrenched with a moderate, riffle dominated gradient. The channel conditions have been modified as a result of extensive floodplain development near the backwater of the Rock Island Dam. Orchards, homes, and roads now occupy much of the channel riparian zone.

Peshastin and Mission creeks are the largest tributaries to the lower Wenatchee River. Peshastin Creek enters about a mile below the town of Peshastin, and Mission Creek runs through the town of Cashmere. Peshastin Creek has been straightened and realigned along much of the channel, and riparian vegetation has been removed and modified in many areas resulting in poor bank protection and a lack of large woody debris. These changes result in higher water velocity rates and unstable channel substrate conditions. Peshastin Creek was extensively placer mined between 1860 and 1940 with some mining still occurring today. Historically, this resulted in almost total loss of the stream channel and floodway. Current practices primarily impact the streambed and banks. Because of the potential financial income from small-scale dredging for gold in creeks, the potential for impacts to the creek channels is significant. Small scale digging and dredging is increasing the instream foot traffic and substrate disturbance in and along the creek channels in areas with known placer deposits such as Peshastin Creek.

Historically, Mission Creek was heavily grazed and some impacts to run-off and sediment supply continue to occur. Mission Creek is one of the two main sources of sediment to the Wenatchee River (NMFS et al. 1998b). Roads encroach into the streamway of Mission Creek with similar channel impacts as seen in the upper watershed tributaries.

An inventory of the Wenatchee River from Icicle Creek to the mouth, based on 1991 conditions, indicated a high level of bank disturbance. Of the 57 miles surveyed, 31 percent had no woody vegetation, 35 percent had only a narrow woody buffer zone, 19 percent of the stream banks were armored with rip-rap, and only 16 percent had intact natural woody vegetation (NMFS et al. 1998b). Most of the channel alterations are the result of railroad, highway, and road construction along the Wenatchee River, and the Nason, Peshastin, and Chumstick creeks. Highway encroachment into the streamway and channel migration zone has cut off the side channel areas in the Sleepy Hollow reach of the lower river. Extensive use of rip-rap along the lower Wenatchee River has decreased the channel sinuosity and reduced the potential for large woody debris recruitment (NMFS et al. 1998b).

Entiat River

The Entiat River valley is formed in the metamorphic rocks of the Swakane gneiss (Cheney 1994). The Entiat fault runs along the southwest side of the valley. A mix of igneous rocks composing the Chelan mountains form the northeast side of the valley.

The upper Entiat River channel begins at the Entiat glacier (river mile 53). The upper river reaches are high gradient, non-fish bearing, mountain channels. The middle reach begins at about river mile 44. The upper portion of the middle reach (from river mile 44 to river mile 33) has typical channel gradients between 4 and 10 percent. This portion of the river has entrenched, cascading and step-pool channels. Substrate is cobble and gravel. Steep valley slopes provide abundant sediment and woody debris supply. Sediment transport rates are high because of the high channel gradients.

Channel modifications related to land use and management influences have been relatively minor in the middle reaches of the river. The middle portion of the middle reach (from river mile 33 to river mile 25 near the USFS boundary) has channel gradients between 2 and 4 percent. Here the channel is moderately entrenched, riffle dominated with infrequently spaced pools. Much of the stream channel below the USFS boundary has been channelized and rip-rapped, with large woody debris and bank vegetation removed. There has been a 30 to 60 percent loss of pool areas in this segment since a survey conducted in the 1930s (USFS 1996).

Historic and current management influences to the channel have been significant including grazing, fires, roads, recreation, and timber harvest. The lower portion of the middle reach (mile 25 to river mile 16.5) is a lower gradient (less than 2 percent) meandering, point bar, and riffle pool, alluvial channel. A terminal glacial moraine at the Potato Creek confluence (river mile 16.5) controls the lower gradient and channel form in this portion of the river. Because of the lower channel gradient, there is a greater tendency for sediment deposition.

Following major floods in the 1940s and 1970s, nearly all of the lower 22 miles of the river channel were modified by dikes and road fills built to protect properties in the floodplain. This constrains the channel, reduces meandering, increases flow velocity, modifies channel bars and substrate, and reduces channel structure. Woody debris are often removed by landowners concerned about flooding which further modifies the channel form.

The lower Entiat River, from the Potato Creek moraine at river mile 16.5 to the river mouth, is an entrenched, meandering, riffle-pool channel with gradients less than 2 percent. Similar to the lower part of the middle reach, this portion of the stream channel has been modified by dikes, road fill, and encroachment. The amount of large woody debris is low and pools have been reduced by 90 percent since the 1930s survey.

Methow River

The Methow River is located in a fault-bounded graben underlain with highly folded sedimentary and volcanic rocks (McGroder and Miller 1989). The area lies between the Gardner mountain fault and the Pasayten fault. The sedimentary rocks weather easily compared to the granites and typically lie beneath thick glacial deposits. Upper valley areas are steep mountains in the Chelan/Colville granitic complex. Pleistocene glaciation has scoured the entire Methow River valley (Soil Conservation Service 1980).

The upper Methow River begins in very high gradient confined mountain channels in the north Cascade mountains. The streams in the headwaters of the basin are valley wall creeks that have steep to very steep gradients, are entrenched, cascading, steep/pool channels with bedrock, cobble, and gravel substrates. The headwater channels grade into moderately entrenched, moderate gradient, riffle dominated channels with cobble and gravel substrates. The upper Methow channel, from river mile 83.2 to river mile 74.5, has a typical gradient between 2.6 and 2.8 percent. The channel here is moderately entrenched, riffle dominated, with infrequent pools. Substrate is cobble and gravel. Steep valley wall slopes provide large woody debris and sediment to the valley bottom alluvial fans. From river 74.5 to river mile 63.2 the channel gradient changes from 1.3 to 0.6 percent, is a meandering and braided alluvial channel with point and transverse bars. Substrate is cobble and gravel.

There is a moderate supply of large woody debris in the upper Methow channel. Pool frequency is generally low in part because of the relatively high bedload transport rates and the moderate large woody debris supply (USFS 1997). The riparian zone is fairly wide and undisturbed (NMFS et al. 1998b). Sediment delivery to the lower Methow River, related to forest management in the upper watershed, is not a significant problem. The USFS estimates that sediment delivery to the Methow River from public lands is about 10 percent higher than natural background levels (USFS 1989). The riparian zone in the upper reaches of the Methow basin are in relatively good condition with only isolated damage from natural events and limited agricultural, grazing, logging, and roads (NMFS et al. 1998b).

The Mid-Methow River basin area includes the mainstem from about 5 miles southeast of the town of Mazama to the river mouth. The Methow River is in a U-shaped, unconfined, alluvial valley from Mazama to river mile 32.5. Wolf Creek enters 2 miles upstream of the town of Winthrop and the Chewuch River enters at Winthrop. The Wolf Creek watershed originates on the south side of Gardner mountain at 8,897 feet elevation, the highest point in Okanogan County. The Methow River is in a U-shaped, moderately confined, alluvial valley from river mile 32.5 to river mile 22.4 near the town of Carlton. The Chewuch River, the largest Methow River tributary, enters in this segment.

From the confluence of the Chewuch River downstream, the Methow River has an average gradient of 0.37 percent. Past use of private bottom lands by livestock and agriculture has impacted about 60 percent of the Methow River channel by erosion, steam bank sloughing, and bank cutting. About 25 percent of the stream banks have been modified and over 60 percent are eroding (NMFS et al. 1998b). This impacts riparian vegetation, stream bank condition, channel pool, and cover conditions.

Roughly half of the Chewuch River basin (primarily the upper basin) is relatively undisturbed with natural channel conditions. Along the Chewuch River for 18 miles below the National Forest boundary to Sheep Creek, there is a lack of large woody debris as a result of stream cleanouts for flood control, salvage of instream wood, and extensive logging along the stream riparian zone. Impacts to the channel along portions of the lower Chewuch River occurred following the 1948 flood when bank protection was added. Sediment delivery is a significant problem in the lower Chewuch River. Impacts from forest roads have occurred along the Chewuch River and tributaries (Boulder, Cub, Falls, Twentymile, and Lake creeks). Boulder Creek watershed has experienced several mass wasting events and significant bank erosion presently occurs in the lower 25 miles of the Chewuch River. Reduced large woody debris in the lower Chewuch River results in reduced pool areas.

The Twisp River enters at river mile 51.8 at the town of Twisp. The Twisp River gradient ranges from 1.7 to 5 percent in the upper reaches and between 0.7 and 1.7 percent in the middle and lower reaches (USFS 1995a). Substrate consists of gravel and sand. Forest roads located in the narrow floodplains of the Poorman, Newby, Little Bridge, Buttermilk, Canyon, and Lime creeks, tributaries of the Twisp River, have impacted channel conditions by direct damage to the riparian zone vegetation and side channel areas and introduction of fines from the road surfaces. The Canyon, Poorman, Little Bridge, Slate and West Fork Buttermilk creeks have degraded riparian areas that impact the channel condition by bank erosion and reduce channel structure because of the lack of large woody debris supply.

Surveys of the Twisp River indicate moderate large woody debris conditions. The better aquatic habitat conditions were found in the relatively undisturbed portions of the Twisp River that had good large woody debris and boulder cover. Reduced large woody debris in the lower Twisp River results in reduced pool areas.

The lower Methow River basin area includes the mainstem from the town of Carlton to the river confluence with the Columbia River. The Methow River is in a U-shaped, confined, alluvial valley from near Carlton to river mile 6.5 and in a U-shaped, moderately confined, alluvial valley from river mile 6.5 to the mouth. The substrate quality in the mainstem Methow River is relatively good (Chapman et al. 1994a). Many channel sections are constrained by rip-rap or channel incision, resulting in a narrower deeper flow during flood flows and less room for channel migration.

Vegetation clearing and stream bank rip-rapping has occurred where more homes were constructed along the valley bottoms. Over 86 percent of the channel has eroded and/or excavated banks or is channelized. Stream-bank erosion is higher in residential and agricultural areas adjacent to the stream banks (USFS 1998). Construction of valley bottom roads and timber harvest have left small to nonexistent stream buffers that do not provide adequate stream bank protection or provide for current and future large woody debris input to the channels. Similar to the lower portions of the tributaries, reduced, large woody debris in the lower Methow River has resulted in reduced pool habitat.

Okanogan River

The Okanogan River valley is a part of the Colville complex of granitic and metamorphic rocks. The Omak Lake fault runs up the Okanogan valley. West of the fault is a mix of igneous plutons, gneiss, and metamorphosed deep ocean sediments of the Okanogan trench deposit. These include argillite, phyllite, volcanic rocks, limited carbonate rocks, and greenstone. The valley has a thick deposit of glacial deposits over the bedrock. On the east side of the basin, east of the Omak Lake fault, the rocks are part of the Okanogan Metamorphic core complex (Cheney 1994); basically an intrusive granitic dome and surrounding metamorphic gneiss.

Nearly all of the subbasin experienced glaciation and is characterized by moderate slopes and broad rounded summits. In the lower valleys, the great regional ice sheets, local alpine valley glaciers, and the tributary rivers have eroded deep, relatively wide valleys. This area has steep to rolling hills along the valley walls with flat to moderate slopes on ancient terraces and along the valley bottoms.

The Okanogan River originates in British Columbia with 29 percent of the watershed area in the United States. The Similkameen River, which enters the Okanogan River from the northwest approximately 75 miles above the mouth, is the main tributary and is located primarily in Canada. The Similkameen River is impassable at Enloe Dam, an abandoned power generation facility, 8.8 miles above the confluence with the Okanogan River.

The lower Okanogan River runs south from Osoyoos Lake at the Canadian border. From river mile 77.6 at Zosel Dam to river mile 64.6 at Mosquito Creek, the unconfined valley is filled with lake bottom sediments. The channel has a gradient of 0.03 percent with multiple channels and eroded banks. From Mosquito Creek (river mile 64.6) to Aeneas Creek (at river mile 52) the river valley is also unconfined. The channel gradient is 0.04 percent with multiple channels and eroded banks. From river mile 52 to McAllister rapids at river mile 42 (12 miles upstream of Omak) the channel is in a moderately confined, alluvial valley. The channel gradient is 0.05 percent with multiple channels and eroded banks. From McAllister rapids to the river mouth, the channel flows through a U-shaped, unconfined alluvial valley. The channel gradient is 0.03 percent with straight, multiple, and channelized forms with eroded banks. The last 17 miles are within the backwater of the Wells Dam.

The Similkameen River, below Enlow Dam, is in a deep, confined, V-shaped valley from river mile 13.8 to river mile 9.2. The lower portion river reach is in a U-shaped, unconfined valley. The channel consists of straight, multiple, and entrenched segments with over half having eroded banks.

Several lakes in the upper Similkameen River and Osoyoos Lake on the Okanogan River trap bedload sediment and a portion of the suspended sediment transported from the upper river basins. Channel substrate in the lower river contains a large proportion of fine sediment because of extensive stream bank erosion, erosion from upland farms and ranches, and basin-wide mass wasting. The riparian habitat of the Okanogan River is the most degraded of the four main Mid-Columbia River tributaries. Lack of riparian vegetation contributes to channel bank instability, sedimentation in the channel, and lack of in-channel pools and cover.

3.1.2.3 Columbia River System

The Columbia basin is comprised of sedimentary and metamorphic rocks in the north and east, and volcanic and igneous rocks in the west, south, and central parts (USGS 1994). The early geologic history is complex with terrenes docking against the ancient North American plate edge in northeast Washington, large and small regions of igneous intrusions, large volcanoes, uplift of the metamorphosed sediments and ocean crust from the edge of the Cascades to the present Pacific coast, volcanic flows across over 100,000 square miles of the Columbia plateau, great glaciers flowing from the mountains of Canada, extensive valley glaciers, and repeated large glacial outburst floods, draining lakes that covered much of Montana, that flooded the entire Columbia River to the Pacific. The Cascade mountains grew across the paths of the west flowing rivers by the late Cenozoic uplift that continues to this day. Only the Columbia and Klamath rivers were able to erode into the rocks fast enough to continue flowing to the Pacific Ocean.

3.1.3 SOILS

Soil types, and the parent materials that they formed in, are as varied in the Mid-Columbia River region as are the landform and climate zones of the area. Ancient soils have formed in residual materials that have weathered in place over very long periods. Relatively young soils have formed in the materials left by the continental glaciers that covered the northern portions of the Mid-Columbia River region and the alpine glaciers that flowed down the tributary rivers from the Cascade mountains. The glaciers deposited outwash from rivers flowing off the ice and glacial tills beneath and just in front of the ice. Along the glacially modified valley walls, soils formed in colluvium, materials that accumulate from hillslope erosion. Common to the valley bottoms and along the narrow mountain river terraces are soils formed in alluvium, materials that are deposited by rivers from the glaciers, glacialfluvial deposits, and recent river deposits. Along the river valleys of the Mid-Columbia River and the main tributaries, well-drained soils have formed in deposits of loess, a mixture of wind blown silt and fine sand derived from till, outwash, and valley bottom river alluvium. Soils have also formed in volcanic ash deposits and ancient lake bottom sediments.

3.1.3.1 Project Area

Dominant soil types are similar at the Wells, Rocky Reach, and Rock Island Dam sites. They include the Peoh soil series, formed in old alluvium with a surface layer of loess and volcanic ash; and the Cashmont soil series, formed in alluvial and colluvial materials derived from basalt. The Peoh soils are a gravely fine sandy loam with slopes of 3 to 15 percent on the terraces. They have moderately rapid permeability, slow to moderate runoff potential, with a water erosion susceptibility of slight to none. The Cashmont soils are a sandy loam with slopes of 3 to 8 percent at the edges of the terraces and near the valley walls. Permeability is moderately rapid, runoff potential is slow to medium, water erosion susceptibility is slight to moderate, and wind erosion potential is slight to moderate. FERC licenses for each project have required the PUDs to prevent soil erosion on lands adjacent to streams or other waters and stream sedimentation. The FERC may order the licensee to take such measures as is needed to protect the soil resources affected by the projects.

3.1.3.2 Associated Tributaries

Wenatchee River

Most of the soils in the forested mountains of the Wenatchee River basin are formed in glacial till mixed with volcanic ash and pumice in the surface layers. Some of the upland areas that were not glaciated have residual soils derived from weathered bedrock or wind blown loess. The most common soils associations are Bjork-Zen and Nard-Stemilt soils (Soil Conservation Service 1973). They are medium textured, steep to very steep soils underlain by bedrock at 20 to 40 inches depth and are mainly well-drained.

The Bjork-Zen association soils are found on terraces and sideslopes in the hilly uplands. They formed in loess or in material weathered from sandstone or schist with some loess and volcanic ash in the surface layer. They have moderately slow to moderate permeability, runoff potential is medium on low gradient slopes, rapid to very rapid on steep slopes, and rapid on irrigated soils. Water erosion susceptibility is moderate on low gradient slopes, high on steep slopes, and high on irrigated soils. These soils occur at elevations from 1,000 to 5,000 feet.

The Nard-Stemilt association soils are found on ridgetops, foothills, sides of terraces, and on mountainous uplands. They formed in glacial till, weathered granodiorite, basalt, gneiss, schist, or sandstone bedrock. Their surface layer contains a mixture of loess and some volcanic ash. They have slow to moderate permeability, runoff potential is slow to medium on low gradient slopes, rapid on steep slopes, and rapid on irrigated soils. Water erosion susceptibility is slight to moderate on low gradient slopes, moderate to high on steep slopes, and high on irrigated soils. These soils occur at elevations from 1,000 to 5,000 feet.

The valley bottom soils are nearly all alluvial with some being of glacial origin. River channels have nearly level bars of recent coarse sand and gravelly alluvium. The terraces and valley bottoms have Burch-Cashmont and Brief-Leavenworth associations (Soil Conservation Service 1973). Both of these soil associations are primarily medium to moderately coarse textured, nearly level to strongly sloping soils on terraces, alluvial fans, bottom lands, and foot slopes. The soils are mainly well-drained. They have moderate to moderately rapid permeability, runoff potential is very slow on low gradient slopes, slow to medium on steep slopes, and rapid on irrigated Brief and Cashmont soils. Water erosion susceptibility is none to slight on low gradient slopes, moderate on steep slopes, and high on irrigated Brief and Cashmont soils.

The Burch-Cashmont association soils are on terraces and low, recent alluvial fans and foot slopes. The soils formed mainly in valley fill and alluvium with some loess and volcanic ash in the surface layer. These soils occur at elevations from 600 to 1,300 feet.

The Brief-Levenworth association soils are on bottom lands, low terraces, and alluvial fans. They consist mainly of well-drained, moderately coarse textured and coarse textured soils that formed in alluvium but have some loess and volcanic ash in the surface layer. These soils occur at elevations from 800 to 2,300 feet.

Mass wasting, including landslides and debris flows, and surface erosion are the main hillslope processes that transport and deliver sediment to the river channels in the Wenatchee basin. When located on steep hillsides, the till/volcanic ash mix (common to many of the upland soils) is vulnerable to mass wasting, erosion, and delivery to the creeks. Areas with extensive logging, road systems, and past grazing in the Mission Creek basin, have accelerated the natural background rates of erosion in the basin. Tractor skidding of logs is still common on private lands and is a significant source of fine sediment to the creeks.

Stream bank erosion and erosion of sediment stored along the stream channels and terraces are the main channel sources of sediment in the stream channels. Bank erosion and transport of channel sediment has been modified in the Wenatchee basin by altered hydrologic conditions that generate larger and more frequent flood flows, by removal of riparian and stream bank vegetation that modifies the amount of large woody debris and channel structure and flow velocities, by rip-rap bank protection, bridge constrictions, dams, and levee structures.

Entiat River

Most of the soils in the forested mountains are formed in glacial till mixed with volcanic ash and pumice in the surface layers. Some of the upland areas that were not glaciated have soils derived from weathered bedrock or loess. The most common soils are the Entiat-Dinkkelman association (Soil Conservation Service 1973). They are predominantly moderately coarse textured, well-drained, steep to very steep soils underlain by bedrock at a 14 to 60 inch depth.

The Entiat-Dinkkelman soils are found on the top and sides of ridges in the foothills and on mountainous uplands. The soils formed in decomposing granodiorite and granite with loess and small amounts of volcanic ash and pumice in the surface layer. They have moderate to moderately rapid permeability, runoff potential is slow to rapid on low gradient slopes, rapid to very rapid on steep slopes, and slight to very rapid on irrigated soils. Water erosion susceptibility is none to slight on low gradient slopes, moderate on steep slopes, and high on irrigated soils. These soils occur at elevations from 1,000 to 4,000 feet.

The river valley soils are nearly all alluvial with some being of glacial origin. River channels have nearly level bars of recent coarse sand and gravelly alluvium. The terraces and valley bottoms have Brief-Leavenworth association soils that are the same as described for the Wenatchee basin valley bottom soils (Soil Conservation Service 1973).

Upland surface erosion from natural and management related causes have a significant influence on the channel in the lower reaches. Mudflows resulting from high intensity rainstorms and rain on snow events following extensive fires in the basin are a significant erosion source and cause of siltation in the channel.

Methow River

The upland soils of the Methow watershed are deep to very shallow mostly grassland soils, rock outcrop, and badland on dissected upland glacial plains and terraces. Common soil associations include the Newbon-Conconully and Kartar-Dinkelman-Springdale associations (Soil Conservation Service 1980).

The Newbon-Conconully association soils formed in glacial till on glaciated plains in the basin. They are deep, well-drained soils with a moderate infiltration rate. The dissected glacial plains form undulating and rolling uplands and steep hillsides. In these areas, the association soils are shallow and include rock outcrops. Most of the soils are a gravely loam to gravely sandy loam. They have moderate to moderately rapid permeability, runoff potential is slow to medium on low gradient slopes, and rapid on steep slopes. Water erosion susceptibility is slight on low gradient slopes, and high to very high on steep slopes. These soils occur at elevations from 1,500 to 3,000 feet.

The Kartar-Dinkelman-Springdale association soils formed in glacial till, outwash, and weathered granite, gneiss, and schist. They are deep, somewhat excessively drained and well-drained soils on glacial plains and terraces. The deeply dissected glacial plains form long, narrow to broad, gently rounded ridges, and long, steep side slopes. The terraces are nearly level and their escarpments strongly sloping. They include sandy loam, gravely sandy loams and sandy gravels. They have moderately rapid permeability, runoff potential is slow to medium on low gradient slopes, and rapid to very rapid on steep slopes. Water erosion susceptibility is slight to moderate on low gradient slopes and moderate to very high on steep slopes. The Kartar and Dinkelman soils have moderate wind erosion potential. These soils occur at elevations 1,500 to 3,500 feet.

The river channels have nearly level bars of recent coarse sand and gravelly alluvium. The terraces and valley bottoms have Owhi-Winthrop association soils upriver of the town of Carlton and Pogue-Cashmont-Cashmere soils downstream. The Owhi-Winthrop association soils formed in glacial outwash and alluvium on terraces. They are deep, well-drained and excessively drained soils found on nearly level and strongly sloping terraces and terrace escarpments. They have moderately rapid to very rapid permeability, runoff potential is very slow to slow on low gradient slopes, and medium to rapid on steep slopes. Water erosion susceptibility is none to slight on low gradient slopes and moderate to high on steep slopes. These soils occur at elevations from 1,400 to 3,000 feet.

The Pogue-Cashmont-Cashmere soils formed in glacial till and outwash on terraces. They are deep, somewhat excessively drained and well-drained soils. They have moderately rapid permeability, runoff potential is slow on low gradient slopes, and medium to rapid on steep slopes. Water erosion susceptibility is none to slight on low gradient slopes and moderate to high on steep slopes. The Cashmont and Cashmere soils have a moderate wind erosion potential. These soils occur at elevations from 700 to1,050 feet.

Surface erosion is not considered a major issue in the basin, although some local area conditions can be improved.

Okanogan River

The main upland soils of the Okanogan watershed are Rock Outcrop-Nevin-Donavan association, Rock Outcrop-Donavan association, Molson-Lithic Xerochrepts-Koepke association, and Republic-Mires-Chesaw association (Soil Conservation Service 1981). These are deep to very shallow mostly forest soils and rock outcrops on mountainous uplands.

The Rock Outcrop-Nevin-Donavan association soils formed on mountain uplands and toe slopes in a mantle of volcanic ash and underlying glacial till. The ridges are gently rounded and the hillsides steep with deep drainages. The soils are well-drained. They have moderate permeability, runoff potential is slow to medium on low gradient slopes, and rapid on steep slopes. Water erosion susceptibility is slight to moderate on low gradient slopes and high to very high on steep slopes. These soils occur at elevations from 2,000 to 4,500 feet.

Rock Outcrop-Donavan association soils formed on steep breaks of the deeply dissected glacial plains in volcanic ash over glacial till. Soil properties are similar to the previously described Rock Outcrop-Nevin-Donavan association soils. These soils occur at elevations from 2,000 to 3,500 feet.

Molson-Lithic Xerochrepts-Koepke association soils formed on alluvial fans, outwash terraces, and terrace escarpments in a mantel of volcanic ash, underlying glacial till, and materials weathered from granite. The ridges are gently rounded and the steep hillsides are cut by deep drainage ways. The soils are well-drained. They have moderate permeability, runoff potential is slow to rapid on low gradient slopes, and rapid on steep slopes. Water erosion susceptibility is slight to high on low gradient slopes and high to very high on steep slopes. These soils occur at elevations from 1,900 to 5,000 feet.

Republic-Mires-Chesaw association soils formed on alluvial fans, outwash terraces, and terrace escarpments in glacial till, reworked glacial till, and outwash. The soils are well-drained to excessively drained. They have dominantly moderate to very rapid permeability, runoff potential is slow to rapid on low gradient slopes, and rapid to very rapid on steep slopes. Water erosion susceptibility is slight to high on low gradient slopes and moderate to very high on steep slopes. These soils occur at elevations from 2,800 to 4,500 feet.

On the terraces, ridges, hillsides, and glacial till plains the common Okanogan basin soils include the Nighthawk-Conconully-Lithic Xerochrepts and Disanutel-Conconully-Nespelem associations. These are deep to very shallow mostly grassland soils, rock outcrop, and badlands on dissected upland plains and terraces.

The Nighthawk-Conconully-Lithic Xerochrepts association soils formed on glacial till plains in glacial till and materials weathered from granite. Most of the association soils are on ridges and hillsides. The ridges are gently rounded and the hillsides are steep. They have moderate to moderately rapid permeability, runoff potential is slow to rapid on low gradient slopes, and rapid to very rapid on steep slopes. Water erosion susceptibility is slight to high on low gradient slopes and high to very high on steep slopes. These soils occur at elevations from 700 to 3,000 feet.

The Disanutel-Conconully-Nespelem association soils formed on plains and terraces in glacial till and lake bottom sediments. The upland plains are undulating and rolling, and the terraces and their escarpments are nearly level and strongly sloping. They have moderately slow to moderately rapid permeability, runoff potential is slow on low gradient slopes, and rapid to very rapid on steep slopes. Water erosion susceptibility is slight on low gradient slopes and high to very high on steep slopes. These soils occur at elevations 1,500 to 3,000 feet.

Common soil associations along the valley bottoms of the Okanogan River and tributaries include the Pogue-Cashmont-Cashmere and Colville-Okanogan associations. These are deep, mostly grassland and meadow soils on terraces and floodplains.

The river channels have nearly level bars of recent sand and gravelly sand alluvium. The terraces along the valleys consist of Pogue-Cashmont-Cashmere association soils as described for the Methow basin valley bottom soils. The Colville-Okanogan association soils are found along the valley bottom floodplains that are subject to flooding. They are deep, somewhat poorly drained and well-drained soils formed in alluvium. They have moderately slow to moderate permeability, runoff potential is very slow, and water erosion susceptibility is none to slight. These soils occur at elevations from 700 to 2,000 feet.

Much of the floodplain on the Okanogan is used for crops and winter livestock and during the summer livestock graze the uplands. Some of the tributaries support year round ranching. High runoff and erosion rates deliver sediment to ditches and creeks during rainstorms and rapid snowmelt periods.

Surface erosion on bottom lands and mass wasting on adjacent hillslopes were serious problems in the 1970s when clean cultivation and rill irrigation were common in the basin. This erosion source has been reduced somewhat by a switch to alfalfa and seed production and by adoption of Best Management Practices (BMPs).

Degraded riparian vegetation, eroding banks, and sediment delivery to the river channel from upland forest, agricultural, and urban areas contribute to the very poor, stream substrate conditions in the Okanogan basin.

3.1.3.3 Columbia River System

A broad range of soil types has formed in the Columbia River basin as a result of the wide range of climate zones and the various types and ages of surface geologic materials. The numerous, high mountain alpine regions of the basin contain young soils because of recent alpine glaciers and constant erosion of the surface. They formed in cold climate conditions with seasonal moisture in the spring, brief, warm but dry summer conditions, and dry, cool fall conditions. Much of the Columbia basin soils formed in dry to moderately dry conditions with cold winters, short moist, spring weather and dry, hot summer, dry, cool fall, and cold winter conditions. From the Mid-Columbia River to the Pacific, the climate varies from dry interior to wet temperate conditions, changing the way the Columbia gorge and lower Columbia surface materials are weathered into soils compared to the mid- and upper-river basin areas.

The great continental glaciers, and resulting lakes and river flood deposits covered the northern portions and main valley of the Columbia resulting in relatively young soils, less than 9,000 years old. Since the 1880s, extensive dry land farming and ranching, and since the 1940s, irrigated farming have modified a large portion of the valley bottom, terrace, and foothill soils in the Columbia basin. During the late 1920s, most of the dry land farms sustained moderate to severe wind erosion of the soils (Social Conservation Service 1973, 1980, 1981). By the mid-1930s, this soil erosion had been reduced as a result of increased rainfall and better cultivation methods.

3.2 FISHERIES RESOURCES

Key Terms

Anadromous – Describes the life-history characteristic of a fish species that reproduces in freshwater, migrates to the ocean for some portion of its rearing stage, and returns to freshwater as an adult.

Biological Productivity – Capacity of an ecological system to produce or support a particular population size of an animal (fish) or plant species.

Brood Stock – Group of fish that are used to provide eggs and sperm to produce a hatchery stock to supplement or replace reproduction in a natural environment.

Critical Habitat – Specific areas occupied by a species that contain physical and biological features essential to the conservation of the species, and which may require special management considerations for protection. These areas might provide space for individual or population growth, nutritional or physiological requirements, breeding and rearing habitat, shelter or cover for protection, and/or represent the historical or geographical distribution of the species.

Evolutionarily Significant Unit– A reproductively isolated, animal or fish population that represents an important component in the ecological/genetic diversity evolution of the species. The unit typically has a relatively confined historical or geographical distribution.

Juvenile Bypass – Facility that is used to collect, divert or guide juvenile fish around a dam and that provides a safer passage route than through the turbine units.

PIT-Tag – A Passive Integrated Transponder tag (about the size of a grain of rice) transmits a digital code unique to an individual fish when the tagged animal passes through a detection tunnel. The tag uses the power emitted by the detection system to transmit the signal, thus it has no batteries (making it functional for years). The tag is typically used on juvenile fish to assess passage survival, as well as survival at the adult stage.

Radio Telemetry – Methodology consisting of attaching or implanting a radio tag in a fish or animal to track its movements or to detect its presence in specific areas that are monitored with a radio receiver and antenna.

Resident – Describes the life-history characteristic of a fish species that spends its entire life in freshwater.

** See Chapter 6 for a complete listing of all Key Terms.*

The affected fisheries resources that occur in the project area include anadromous and resident fish species, benthic macroinvertebrates, and aquatic vegetation communities. The anadromous fish species include: chinook salmon, coho salmon, sockeye salmon, steelhead, Pacific lamprey (*Entosphenus tridentatus*), and the semi-anadromous white sturgeon (*Acipenser transmontanus*). Some 46 other non-migratory fish species also occur in the Mid-Columbia River basin.

The salmonid species found primarily in the tributary or non-main stem areas include kokanee (landlocked sockeye salmon), bull trout (*Salvelinus confluentus*), rainbow trout (resident form of steelhead), westslope cutthroat trout (*O. clarki lewisi*), mountain whitefish (*Prosopium williamsoni*), and pygmy whitefish (*P. coulteri*). These salmonid species occupy some of the same habitats as the Plan species, and are therefore most likely to be affected by the proposed action.

License articles, amendments, and settlement agreements pertinent to fishery resources are described in Chapter 2 of this EIS. These include project facilities, operations, and hatcheries that were developed to avoid and minimize fish injury or losses as a result of passing through the dams.

3.2.1 THE LISTINGS UNDER THE ENDANGERED SPECIES ACT

On August 18, 1997, the NMFS published notice in the Federal Register, listing the upper Columbia River evolutionarily significant unit of steelhead as an endangered species under the Endangered Species Act (NMFS 1997). In response to this listing, Chelan and Douglas County PUDs filed interim protection plans with FERC for the Wells, Rocky Reach, and Rock Island projects. The interim protection plans established a program to provide short-term compliance with the Endangered Species Act until the Anadromous Fish Agreements and HCPs could be approved. In accordance with the applications filed by the PUDs, FERC and NMFS are consulting under Section 7 of the Endangered Species Act, concerning FERCs approval of the interim protection plans. Also included in the consultation is the upper Columbia River evolutionarily significant unit of spring-run chinook salmon (which was listed as an endangered species on March 24, 1999 (NMFS 1999a)) and the evolutionarily significant unit of Mid-Columbia River steelhead (which was listed as a threatened species on March 25, 1999 (NMFS 1999b)).

On February 16, 2000, NMFS published notice of the critical habitat designation for the two endangered species (NMFS 2000). This designated the major river basins known to support the evolutionarily significant units, including the Wenatchee, Entiat, and Methow rivers, as well as the Columbia River and estuary for spring-run chinook salmon. These same areas were designated as critical habitat for the steelhead evolutionarily significant unit, as well as the Okanogan River basin.

The Columbia River bull trout populations were also listed as threatened under the Endangered Species Act in June 1998 (USFWS 1998). Because the Mid-Columbia River bull trout populations are not considered anadromous, their protection has not been included in the interim protection plans. However, bull trout are occasionally observed passing through the adult and juvenile passage facilities at the Mid-Columbia River dams. Currently, no biological assessments have been written for bull trout at the projects, however, informal Section 7 consultations have been initiated with the USFWS.

3.2.2 ANADROMOUS FISHERY RESOURCES

Four species of anadromous Pacific salmonids occur in the Columbia River basin upstream of Bonneville Dam: chinook, coho (hatchery origin), sockeye salmon, and steelhead. Although coho salmon were once present in some tributaries in the Mid-Columbia River region (Mullan 1984; Oregon Department of Fish and Wildlife [ODFW] and WDFW 1995), native populations are extinct (Nehlsen et al. 1991). However, hatchery coho salmon have been planted in the Mid-Columbia River region in recent years in an attempt to reestablish the runs. The HCPs apply to all four of these species (Plan species), although the incidental take portion of the agreement does not apply to coho salmon, as native coho salmon are extirpated from the region. General life-history descriptions and current and historic run size information for these species in the Columbia River system and the Mid-Columbia River reach are provided below.

3.2.2.1 Life History

The timing of adult migration, spawning, incubation, hatching, emergence, juvenile rearing, smolt outmigration, and ocean residence periods differ between species and some of these differences have been used to separate several species into different races/demes. This differentiation is applied to chinook and steelhead because these species exhibit substantial variation in life-history characteristics.

There are three races/demes of chinook salmon in the Columbia River basin: spring, summer, and fall; and two races of steelhead: summer and winter. These race designations are based on the time that returning adults typically enter the river. However, in recent years the comparison of overall life-history characteristics and genetic assessments have shown these designations are not always accurate (Chapman et al. 1994a).

A more consistent differentiation scheme, that characterizes the stocks as either ocean-type or stream-type fish, is based on their overall life-history characteristics. Ocean-type juveniles migrate to sea as subyearlings, spend most of their ocean life in coastal waters, and return to freshwater as adults, a few months prior to spawning. Stream-type fish migrate to sea as yearlings, exhibit extensive offshore migrations, and return to freshwater many months before spawning (Healey 1991). Within the Columbia River basin, the production of stream-type fish typically occurs higher in the watersheds than ocean-type fish which typically spawn in mainstem areas and lower tributaries (Waknitz et al. 1995). Mid-Columbia River chinook populations exhibit both types of life-history characteristics.

Mid-Columbia River spring-run chinook salmon enter the lower river in the spring and are categorized as stream-type fish because they typically rear in freshwater for more than 1 year before migrating to the ocean as yearlings. They also tend to spawn in the upper reaches of tributary streams. Although summer- and fall-run chinook enter the lower river at different times, and usually spawn in different areas (summer-run chinook tend to spawn higher in the system than fall-run chinook), they both exhibit ocean-type life-history characteristics (spend less than 1 year in freshwater). In addition, there is considerable genetic homogeneity between these two groups. As a result, they are considered part of the same evolutionarily significant unit and are usually called either summer-run chinook or summer/fall-run chinook (Waknitz et al. 1995).

For the purposes of the HCPs, summer- and fall-run (ocean-type) chinook salmon are treated as indistinguishable races/demes. However, when spawning is discussed, summer- and fall-run chinook are separately identified and discussed. The fall-run chinook component are defined as those races/demes that spawn in the mainstem Columbia and Snake rivers, and in the extreme lower reaches of primary tributaries to the mainstem Columbia. The summer-run chinook component are those stocks that do not spawn in the aforementioned areas but do outmigrate as subyearling juveniles (age 0+), the same as fall-run chinook.

Spring-Run Chinook Salmon

The upper Columbia River evolutionarily significant unit of spring-run chinook salmon was listed as endangered under the Endangered Species Act in March 1999 (NMFS 1999). These stream-type chinook salmon exhibit substantially more diverse life-history strategies than ocean-type salmonids, probably as a result of changing environmental conditions over their extended freshwater residence time. Spring-run chinook salmon are found in all of the major watersheds in the Mid-Columbia River except the Okanogan River drainage. The Okanogan River basin was also not included in the critical habitat designation for upper Columbia River spring-run chinook salmon (NMFS 2000). Adult spring-run chinook salmon return to Mid-Columbia River tributaries from late April through June, after spending 2 to 3 years in the ocean (Chapman et al. 1995a). Chinook salmon passing the Rock Island Dam after June 23 are considered summer/fall-run chinook salmon (Peven 1992). After entering the tributaries, the adults hold in the deeper pools and under cover until onset of spawning. They may spawn near their holding areas or move upstream into smaller tributaries. Spawning generally occurs from late July through September and typically peaks in late August, although the peaks vary among tributaries (Chapman et al. 1995a; Peven 1992).

Spring-run chinook salmon eggs hatch in late winter and the fry emerge from the gravel in April and May (Peven 1992). Most of these juveniles rear in freshwater for 1 year before migrating to the ocean, passing the Mid-Columbia River dams between mid-April and mid-June (Mullan 1987). The outmigration of naturally produced spring-run chinook salmon juveniles typically occurs over a longer period than hatchery fish. In addition, naturally produced juveniles are generally smaller than hatchery fish, which might explain their slower outmigration.

The extended time spent in freshwater (as adults and juveniles) makes spring-run chinook salmon more susceptible to impacts from habitat alterations than the ocean-type chinook (summer/fall-run chinook). Water withdrawal in some areas has a deleterious effect upon stream-type salmonid spawning distribution, incubation survival, and late summer rearing habitat quality (Chapman et al. 1995a).

Summer/Fall-Run Chinook Salmon

Most summer/fall-run chinook enter the Columbia River from late May to early July and pass the Mid-Columbia River dams from late June through October, after spending 3 or 4 years in the ocean (Peven 1992). Although these two groups of fish are considered part of the same evolutionarily significant unit, and are characterized as ocean-type fish, they spawn in different areas of the basin (Waknitz et al. 1995). Summer-run chinook spawn in the lower portions of the Similkameen River below Enloe Dam, the Okanogan River downstream of Osoyoos Lake, the lower 50 miles of the Methow River, the Wenatchee River downstream of Lake Wenatchee, and in the lower Chelan River (Chapman 1994b). Spawning typically occurs during late September through November, peaking in October (Peven 1992).

About 70 percent of the Mid-Columbia River fall-run chinook spawning occurs from Vernita Bar (about 4 miles downstream of Priest Rapids Dam) downstream through the Hanford reach to the upper reaches of McNary pool (Carlson and Dell 1990). Peak spawning at Vernita Bar occurs in November (Carlson and Dell 1989, 1990, 1991, and 1992). Fall-run chinook are also known to spawn in the tailraces of Priest Rapids, Wanapum, Wells, and Chief Joseph dams (Chapman 1994a), and possibly below Rocky Reach and Rock Island dams (Dauble et al. 1994). Fall-run chinook spawning also occurs in the Priest Rapids reservoir (Carlson and Dell 1989, 1990, 1991, and 1992), Rock Island reservoir (Chelan County PUD 1991), Rocky Reach reservoir (Giorgi 1992), and upstream of Wells Dam (Hillman and Miller 1994; Chapman et al. 1994a; Swan et al. 1994; Bickford 1994), where suitable water velocities and substrate conditions occur. However, the extent and magnitude of this spawning activity is unknown.

Juveniles emerge in April and May and move downstream within a few days to a few weeks (Chapman et al. 1994a). Ocean-type fish (summer- and fall-run chinook) generally migrate to the ocean as age-0 subyearlings in late summer and early fall months, passing the Mid-Columbia River dams between June and August (Mullan 1987; Peven 1992; Chapman et al. 1994a). Based on limited snorkel observations, summer-run chinook salmon leave the Wenatchee River in summer as expected for ocean-type fish, but some may rear in the mainstem Columbia River for extended periods (Chapman 1988). This phenomenon probably occurs on other tributaries to the Mid-Columbia River, and suggests that mainstem reservoirs largely influence the success of ocean-type salmonids.

Relative to other populations, ocean-type salmonids spend the shortest amount of their life in the tributaries. An important factor that separates this group from others is that juvenile fish have exited the subbasin prior to the lowest flows in fall and are not subject to harsh conditions in winter.

Sockeye Salmon

The life history of sockeye salmon is perhaps the most complex of any Pacific salmon. Although they share the same general life cycle as chinook salmon, multiple forms of the species are common and play important roles in its long-term survival. Kokanee, a resident form of sockeye salmon, occasionally migrate to sea and return as adults, however there is limited evidence that these fish contribute substantially to sockeye salmon production (U.S. Department of Commerce et al. 1994). A third form, known as residual sockeye salmon, often occur together with sockeye salmon. Residuals are believed to be the progeny of sockeye salmon, but are generally non-anadromous themselves.

The distribution of sockeye salmon in the Mid-Columbia River region is limited to the Wenatchee and Osoyoos lakes, in the Wenatchee and Okanogan watersheds, respectively. Limited numbers of adults and juveniles are periodically detected however, in the Methow and Entiat rivers (Carie 1996), Icicle Creek, and in isolated areas of the Mid-Columbia River (Chapman et al. 1995b). Despite the considerable mixing of the Wenatchee and Okanogan sockeye salmon stocks during the Grand Coulee Fish Maintenance Project (Fish and Hanavan 1948), the two populations have a high level of genetic distinction in allele frequencies (Winans et al. 1995; Biological Review Team 1996).

The Grand Coulee Fish Maintenance Project was a program to preserve the upper Columbia anadromous fish runs after the construction of Grand Coulee Dam. The project trapped all adult fish at Rock Island Dam, and transported them to tributary spawning areas for natural production or to hatcheries for artificial production. The hatchery fish were then released into tributary streams downstream of Grand Coulee Dam. This was the beginning of the Leavenworth National Fish Hatchery complex.

Adult sockeye salmon begin entering the Columbia River in May and pass the Mid-Columbia River dams between late May and mid-August (BPA et al. 1994a). Adults reach natural lakes in the Okanogan and Wenatchee watersheds during July through September and spawn during September and October (Mullan 1987; Chapman et al. 1995b). Sockeye salmon fry emerge in March and April and move into freshwater lakes to rear for 1 to 3 years before migrating to the ocean. Sockeye salmon smolts typically pass the Mid-Columbia River dams between mid-April and late May during their outmigration (Chapman 1995b; Columbia Basin Fish and Wildlife Authority 1990).

Steelhead

Although both summer and winter steelhead runs occur in the Columbia River basin, winter steelhead typically occur in tributary streams downstream of Bonneville Dam. Although steelhead exhibit an extremely complex array of life-history characteristics (Peven et al. 1994), NMFS considers all steelhead returning to areas upstream of the Yakima River confluence as belonging to the same evolutionarily significant unit (61 Federal Register, 960730210-6210-01). This evolutionarily significant unit includes steelhead spawning in the Wenatchee, Entiat, Methow, and Okanogan watersheds, and smaller tributaries to the Mid-Columbia River. Only anadromous forms of steelhead are listed due to uncertainties regarding the status of resident forms (rainbow trout), and interactions between the two life-history forms. The steelhead produced at the Wells Fish Hatchery are included in the evolutionarily significant unit because NMFS considers them essential to the recovery of natural populations.

Adult steelhead enter the Columbia River during March through October after spending 1 or 2 years in the ocean. Returning adults typically pass the Mid-Columbia River dams from June through late September. Not only is the adult migration protracted over a long period, spawning does not occur until the following March through July (Columbia Basin Fish and Wildlife Authority 1990; Peven 1992). Unlike other anadromous salmonids, some steelhead adults (kelts) return to the ocean after spawning and may spawn more than once during their lifetime (Peven 1992). However, repeat spawning in the Mid-Columbia River region is typically 2.1 percent or less (Brown 1995).

Steelhead eggs incubate from late March through June, and fry emerge in late spring to August. Fry and smolts disperse downstream in late summer and fall. Their use of tributaries for rearing is variable, depending upon population size, and both weather and flow conditions at any given time. Smolts typically leave the Wenatchee River in March to early June, after spending 1 to 7 years in freshwater, but most leave after 2 to 3 years (Peven et al. 1994). Some steelhead are thought to residualize and live their entire lives in freshwater.

As a result of their varied length of freshwater residence, their variable ocean residence, and their spatial and temporal spawning distribution within a watershed, steelhead exhibit an extremely complex mosaic of life-history types (Peven et al. 1994). Such life-history diversity is an effective strategy for ensuring the long-term viability of the populations. Steelhead populations in the Mid-Columbia River were depressed by overfishing in the period before the 1950s and continued through the 1970s (Chapman et al. 1994a). However, spawner/recruitment curves constructed by Mullan et al. (1992) indicate that factors outside the tributary watersheds (primarily mainstem passage mortalities) have significant impacts to wild steelhead. Hatchery practices in the past have also contributed to the stock declines, including the practice of planting catchable trout, which have caused an increase in the incidental catch of steelhead (Chapman et al. 1994a).

Coho Salmon

Historically, coho salmon were present in both the Columbia and Snake river basins. Major Columbia River tributaries that supported coho salmon include the Wenatchee, Entiat, Methow and Okanogan rivers. Mid-Columbia River coho salmon were decimated in the early 1900s by impassable tributary dams, unscreened irrigation diversions, and extensive harvest. Irrigation, livestock grazing, and mining were major contributors to salmon and steelhead habitat destruction before 1910. Later, timber harvest, fire management, and irrigation impacts were of the most importance. Construction of dams in the tributaries also degraded habitat and blocked access to large portions of the upper Columbia River (BPA 1999). Indigenous coho salmon no longer occur in the Mid-Columbia River region.

Because the historical stocks of coho salmon were decimated near the turn of the century, most life-history information is derived from affidavits from older residents. These accounts support the belief that coho salmon probably returned to the Mid-Columbia River tributaries in August and September. In the lower Columbia River tributaries, coho salmon spawn from October to mid-December. Juveniles typically spend 1 year in freshwater before outmigrating as yearling smolts in April and May. Coho salmon typically spend about 18 months at sea before returning to spawn (BPA 1999).

3.2.2.2 Abundance

The best available historical data on the Columbia River salmon runs are the records from the commercial fishing industry. The historical peak catch of Columbia River chinook salmon occurred in 1883 when almost 43,000,000 pounds were taken. This also corresponded to the peak number of canneries operated on the Columbia River (39). At that time most of the commercial catch consisted of chinook salmon, primarily the high quality, spring-run chinook salmon. Sockeye salmon and steelhead first entered the official catch records in

1889. Large fluctuations in the chinook catch occurred between 1889 and 1920 although the general trend was at a level of about 28,000,000 pounds. Between 1920 and 1935, the catch declined to a mean of about 18,000,000 pounds (Bell 1937).

Based on commercial harvest data around the turn of the century, spring-run chinook salmon are thought to comprise between 11 and 15 percent of the estimated 3.8 to 4.3 million chinook entering the river (Chapman 1986). However, prior to the extensive commercial harvest in the lower river before the turn of the century, the separation in run-timing between the different races/demes of chinook salmon was believed to have been much less defined and resulted in greater temporal and spatial overlap between the groups (Mullan 1987). Thompson (1951) showed that, historically, Columbia River chinook salmon exhibited a continuous, bell-shaped, run-timing distribution, entering the river mouth from February through late November, peaking in mid-June.

The fishing regulations before and after the turn of the century resulted in a greater exploitation of the spring- and summer-run fish, and as this portion of the run declined, the fishing seasons were extended to include earlier and later portions of the overall chinook run. Fulton (1968) reports that the spring- and summer-runs dominated the catch until about 1928, when the fall-run catch became larger. This exploitation pattern has resulted in greater separation between the three races of chinook (spring, summer, and fall) and less mixing between groups on the spawning grounds.

The “bell shaped”, historical, run-timing distribution resulted in some uncertainties regarding the partitioning of the lower river harvest. This has led to considerable confusion regarding the ancestral relationships among chinook salmon populations in the basin (Waknitz et al. 1995).

Spring-Run Chinook Salmon

Counting of spring-run chinook salmon began at Rock Island Dam in 1935. The numbers were less than 3,000 fish between 1935 and 1938, and rose somewhat erratically to a peak of about 26,000 in the mid- 1980s. The counts dropped off dramatically after 1993 and have averaged about 2,900 between 1994 and 1998 (Chapman et al. 1995a; Fish Passage Center 1999).

Summer/Fall-Run Chinook Salmon

Summer/fall-run chinook salmon counts at Rock Island Dam averaged about 5,700 (adults and jacks) between 1933 and 1942; they remained less than 9,000 until 1951 and ranged between about 12,700 and 38,600 through 1998 (Chapman et al. 1994b; Fish Passage Center 1999). In recent years (1994 to 1998) the counts at Rock Island Dam have averaged about 18,400 fish.

Steelhead

Between 1933 and 1959, adult steelhead counts at Rock Island Dam averaged 2,600 to 3,700 fish. In the 1960s and 1970s, with the beginning of hatchery releases, the counts averaged 6,700 and 5,400, respectively. The counts generally increased in the 1980s to between about 7,000 and 32,000. However, between 1990 and 1998, the counts have declined to about 4,600 to 12,400 (average about 7,200) (Chapman et al. 1994b; Fish Passage Center 1999).

Sockeye Salmon

Sockeye salmon counts at Rock Island have shown substantial variation since 1933 (ranging between about 950 and 164,500). The counts were generally low between 1933 and 1945 (950 to 40,700), increased to between 4,700 and 164,500 through 1969, and between 14,750 and 109,100 through 1993. Since 1993 the counts have ranged between 8,500 and 41,500 (Chapman et al. 1995b; Fish Passage Center 1999).

Coho Salmon

Indigenous natural coho salmon no longer occupy the Mid-Columbia River basin (BPA 1999). After completion of Priest Rapids Dam in 1960, peak escapement estimates probably never exceeded 10,000 fish. Since 1988, adult counts at Priest Rapids Dam have averaged only 16 coho salmon, probably a result of hatchery strays from Turtle Rock Hatchery releases. Self sustaining populations of coho salmon have not been reestablished in the Mid-Columbia River, despite plantings of 46 million fry, fingerlings, and smolts between 1942 and 1975.

3.2.2.3 Spawner Distribution

Fulton (1968) reported that spring-run chinook salmon generally spawn in small- and medium-sized tributaries of the Mid-Columbia River, while summer-run chinook salmon generally spawn in intermediate and large tributaries and in the middle reaches of the mainstem. French and Wahle (1960, 1965) observed spring- and summer-run chinook salmon spawning in the same areas of the Wenatchee and Methow rivers, although summer-run fish were more abundant in the lower reaches and spring-run fish more abundant in the upper reaches of these systems. Fulton (1968) also reported that spring-run chinook salmon typically spawn from late July to late September; summer-run between mid-August and mid-November; and fall-run between September and December.

Spawning distribution in the Mid-Columbia River basin is somewhat confounded by the fact that spring- and summer-run chinook salmon spawning information was combined in older reports, and summer- and fall-run spawning information was combined in more recent reports. The following distributions (Table 3-1) are based primarily on Fulton (1968) who combined spring- and summer-run chinook salmon.

TABLE 3-1. SPAWNING DISTRIBUTION OF ANADROMOUS FISH SPECIES IN THE MID-COLUMBIA RIVER WATERSHEDS

SPECIES	WATERSHED	TRIBUTARIES
Spring and Summer Chinook (Fulton 1968; Chapman et al. 1995a)		
	Wenatchee River	Peschastin, Icicle, and Nason creeks; Chiwawa, Little Wenatchee, Wenatchee, and White rivers
	Entiat River	Most of mainstem
	Methow River	Mainstem Methow River, lower mainstem Twisp River, and lower Chewuch River
	Okanogan River	Mainstem Similkameen River; Salmon and Omak creeks
Fall Chinook (Fulton 1968)		
	Wenatchee River	Mouth of the Wenatchee River
Steelhead (Fulton 1968; Chapman et al. 1994b)		
	Wenatchee River	Peschastin, Icicle, Chiwaukum, Nason and lower Mission creeks; Chiwawa, Little Wenatchee, Wenatchee, and White rivers
	Entiat River	Entiat and Mad rivers
	Methow River	Methow mainstem; Gold, Wolf, and Early Winters creeks; Lost River
	Okanogan River	Salmon and Omak creeks; upper Simikameen River
Sockeye (Fulton 1970)		
	Wenatchee River	Little Wenatchee, Nepeequa and White rivers
	Okanogan River	Mainstem Okanogan and tributaries above Osoyoos Lake

3.2.3 Tributary and Mainstem Development

The congressional authorization of Grand Coulee and Rock Island dams during the early 1930s was the beginning of a period of intense dam construction in the Columbia River basin. The construction of Grand Coulee Dam in 1934 blocked over 1,000 miles of habitat in the Columbia River basin to anadromous fish because no adult fishways were built as part of the project (see Figure 1-1 for general location of Columbia River dams). Another 52 miles of habitat were blocked in 1961 with the completion of Chief Joseph Dam. The completion of the Hells Canyon complex, in 1961 blocked about 350 miles of mainstem Snake River habitat to anadromous fish. Dworshak Dam is the upstream limit of salmon and steelhead migration on the North Fork of the Clearwater River (BPA et al. 1994a). All dams downstream of these projects are equipped with facilities to allow passage of adult anadromous fish.

Construction began on the Rock Island Dam in 1929 and was completed before the beginning of the 1932 fish migrations. Fish returning to upstream spawning areas were counted as they passed through the fishladders at the dam. Evaluations showed that sockeye salmon had little difficulty finding and ascending these ladders, although this was not the case for chinook salmon. Chinook salmon were observed jumping at the dam, and those collected and examined from the fishladders showed about a 20 percent injury rate, most of which were in the head and snout region, apparently due to the fish jumping at the rocks below the dam (Bell 1937).

In addition to the injury rate observed on the chinook salmon adults passing Rock Island, substantial delays in their migration were also apparent. Prior to the completion of Rock Island Dam the peak catch in the tribal fisheries at Kettle Falls occurred on about August 1. However, in the years immediately following the completion and operation of the dam, the chinook salmon were delayed 20 to 25 days (Bell 1937). Although the number of fish caught in this fishery also declined after completion of the dam, there is no direct evidence that this was related to passage problems at the dam. As a result of these apparent deficiencies, a third ladder was constructed prior to the 1936 migration period that provided substantial improvements.

Between 1946 and 1991, the estimated minimum number of upriver spring-run chinook salmon entering the Columbia River followed a generally declining trend, while the number of fish passing Rock Island Dam generally increased. The increasing trend in fish passage at Rock Island is likely due to the curtailment of harvest in the lower river, and the effects of the hatchery programs associated with the Grand Coulee Fish Maintenance Program. In addition to Grand Coulee, Rock Island and Chief Joseph dams, four other mainstem dams were constructed in the Mid-Columbia River between 1959 and 1967. These run-of-the-river projects are: Priest Rapids (1959) and Wanapum (1963) that are owned and operated by Grant County PUD, Rocky Reach (1961), and Wells Dam (1967).

3.2.4 Hatchery Programs

The first fish hatchery in the Columbia River basin was built in 1877 on the Clackamas River, a tributary of the Willamette River in Oregon. This was the first of several hatcheries constructed through the turn of the century to support commercial fisheries, including the Grand Coulee Fish Maintenance Program hatcheries beginning in 1939 and those of the Federal Bureau of Fisheries. A second phase of major hatchery construction occurred in the basin in the 1950s when the Mitchell Act passed in the U.S. Congress in 1938.

Today, there are approximately 90 fish production facilities in the Columbia basin that support important Indian treaty, sport, and commercial fisheries. The annual catch from Mitchell Act facilities alone averaged 2 million adult anadromous salmonids per year between 1960 and 1985. It is estimated that hatchery fish currently account for 70 percent of spring-run chinook salmon, 80 percent of summer-run chinook salmon, 50 percent of fall-run chinook salmon and 70 percent of steelhead in the Columbia River basin (BPA et al. 1994a). In addition, nearly all of the coho salmon returning to the Columbia River are of hatchery origin.

The Grand Coulee Fish Maintenance Program included the first hatchery program in the Mid-Columbia River region. Under this program adult steelhead, chinook, sockeye, and coho salmon were to be trapped in the Rock Island Dam fishways and transferred to a planned hatchery facility on Icicle Creek, a tributary of the Wenatchee River. Fish would be held and spawned at this facility to provide a supply of eggs to substations on the Entiat, Methow, and Okanogan rivers. However, these hatchery facilities were not constructed before the start of the 1939 anadromous fish runs. Thus, fish trapped at Rock Island Dam were transferred to holding areas established in the three Mid-Columbia River watersheds to allow natural spawning as a means to propagate the stocks.

Holding areas were established in Nason Creek, a tributary of the Wenatchee River, for spring-run chinook salmon and steelhead. The mainstem Wenatchee and Entiat River holding areas were used to propagate summer and fall-run chinook salmon and steelhead, and Lake Wenatchee and Osoyoos Lake were used to propagate sockeye salmon. The original success of this natural spawning program led to the inclusion of a natural spawning component in the Grand Coulee Fish Maintenance Program in subsequent years. The Leavenworth National Fish Hatchery and satellite facilities were completed and operational in 1940 to continue the Grand Coulee Fish Maintenance Program. The trapping program at Rock Island Dam ended in late fall 1943, while the hatchery component of the Grand Coulee Fish Maintenance Program continues to the present day.

The Leavenworth National Fish Hatchery on Icicle Creek was completed and operational in 1940. Over the years, varying numbers of eyed eggs were shipped from this facility to the Entiat and Winthrop substations for hatching, rearing and release. Fingerlings were also released directly into the Wenatchee system from the Leavenworth Hatchery. The Grand Coulee Fish Maintenance Program used all adult anadromous salmonids captured at Rock Island Dam between the years 1939 and 1943, after which, portions of the adult runs were allowed to pass Rock Island to migrate and spawn naturally.

The Grand Coulee Fish Maintenance Program had a profound impact on the genetic integrity of the various native fish runs in the Mid-Columbia River region. The mixing of stocks, as a result of this program, eliminated the genetic uniqueness of the individual Mid-Columbia River runs and produced homogenized stocks that were used in subsequent years to seed the entire region. Exacerbation of these impacts occurred in subsequent years with the extensive mixing of hatchery progeny with progeny from wild spawning adults, and the inclusion of non-native broodstock in the hatcheries.

3.2.4.1 Hatchery Compensation for Mid-Columbia Habitat Inundation

Further expansion of the Mid-Columbia River hatchery system occurred between 1961 and 1967, with the construction of four hatchery facilities as compensation for lost fish production from inundation of the mainstem Columbia River by Priest Rapids, Wanapum, Rocky Reach, and Wells dams. The Priest Rapids, Turtle Rock and Wells hatchery facilities were originally designed as spawning channels to allow natural spawning activity. However, the limited success of these channels led to the construction of conventional fish production hatcheries in the early 1970s. The fourth mainstem compensation facility, the Chelan Hatchery, is also a conventional hatchery.

3.2.4.2 Hatchery Compensation for Mid-Columbia Tributary Losses

The third phase in the development of the Mid-Columbia River hatchery program began in 1989 with the construction of several facilities to enhance tributary production. These facilities include the Methow Hatchery and two satellite acclimation ponds, the Eastbank Hatchery and five satellite locations, and the experimental facilities at Cassimer Bar Hatchery. These facilities were the result of long-term settlement agreements for the Wells and Rock Island projects to compensate for ongoing fish passage losses at the projects. With the exception of the Cassimer Bar facility, which is operated by the Colville Tribe, the PUD hatchery facilities are operated by WDFW.

3.2.4.3 Current Hatchery Production

Between 1980 and 1998, summer-run chinook salmon releases in the Mid-Columbia River region averaged about 2.22 million fish and ranged between 0.27 and 3.89 million fish. Spring-run chinook salmon releases ranged between 1.33 and 6.46 million fish, and averaged about 4.59 million fish for these same years. An average of about 1.46 million juvenile steelhead were also released in the Methow, Entiat, and Wenatchee river systems, as well in the mainstem Columbia River (from the Ringold Hatchery) between 1980 and 1998.

Hatchery releases in 1998 included about 340,000 coho salmon in the Methow River, about 285,000 yearling sockeye salmon from net pens in Lake Wenatchee in 1998, and about 80,500 subyearling sockeye salmon near the mouth of the Okanogan River (Table 3-2).

TABLE 3-2. HATCHERY FACILITIES OWNED OR FUNDED BY THE MID-COLUMBIA RIVER PUDS IN COMPENSATION FOR PROJECT IMPACTS TO ANADROMOUS FISH SPECIES

COMPENSATION OBJECTIVE/FACILITY	OPERATOR	YEAR	SPECIES	PRODUCTION LEVELS
Assumed Wells Project Mortality				
Cassimer Bar Hatchery	Colville Tribe	1992	Sockeye	200,000
Osoyoos Lake Net Pens		1993	Sockeye	200,000
Wells Hatchery	WDFW	1992	Summer Steelhead	180,000
Methow Hatchery	WDFW	1992	Spring Chinook	250,000
Chewuch Pond		1992	Spring Chinook	250,000
Twisp Pond		1992	Spring Chinook	250,000
Original Wells Pool Inundation				
Wells Hatchery	WDFW	1967	Summer Chinook	800,000
			Fall Chinook[1]	100,000
			Summer Steelhead	300,000
Original Rocky Reach Pool Inundation				
Chelan and Turtle Rock Facilities	WDFW	1995	Summer Steelhead	200,000
Rocky Reach Hatchery and Turtle Rock Pond (combined)	WDFW	1969	Summer Chinook	1,600,000
			Fall Chinook	200,000
Ongoing Rock Island Inundation/Project Mortality				
Eastbank Hatchery	WDFW	1989	Summer Steelhead	200,000
Carlton Pond		1989	Summer Chinook	400,000
Dryden Pond		1989	Summer Chinook	864,000
Simikameen Pond		1989	Summer Chinook	576,000
Chiwawa Pond		1989	Spring Chinook	672,000
Lake Wenatchee Net Pens		1989	Sockeye	200,000

[1] Fall chinook program is voluntary, not part of the FERC license or settlement agreement

3.2.4.4 Interaction Between Hatchery Stocks and Wild Stocks

Hatchery fish can directly impact wild stocks through increased competition, disease transmission, and loss of distinct genetic characteristics. They can also have indirect impacts by increasing the susceptibility of wild stocks to predation.

Competition

Competition for food and space between hatchery and wild juvenile salmonids is greatest at hatchery release sites, where small numbers of wild fish must compete for available resources with large numbers of hatchery fish. Although, this competition at the release site is expected to diminish as hatchery fish disperse, the initial competition might force wild fish from preferred habitats and increase their susceptibility to predation (BPA et al. 1994c).

Disease

Pathogens that cause disease in salmon and steelhead are present in both wild/natural and hatchery populations, although the hatchery environment encourages the spread of pathogens due to relatively high fish densities. However, there is little information on the impacts of infectious diseases on natural production, and no direct evidence of increased incidence or prevalence of disease in wild/natural populations downstream of hatcheries. Although horizontal (fish to fish) transmission of some pathogens might occur when diseased and healthy fish are held in close proximity, there is little information that suggests similar transmissions in the free-flowing river environment (BPA et al. 1994c).

Genetics

Hatchery management activities can affect the genetic integrity of wild/natural populations in several ways. The release of large numbers of hatchery fish tends to increase the hatchery component in the total adult population. Subsequent harvest regulations based on a proportion of the total run can result in greater impacts to wild/natural fish populations than the hatchery stock. Large hatchery populations can withstand higher harvest levels than a small natural population because it takes fewer adult spawners to fully stock a hatchery program compared to a natural system where mortality rates are substantially greater. Selective hatchery breeding protocols, the straying of hatchery fish to natural spawning areas, and the use of non-indigenous hatchery stocks tend to deplete the native genetic characteristics of the wild population (BPA et al. 1994c).

The use of natural broodstocks can also reduce the number of natural spawners. Early broodstock collections in the Columbia River basin may have led to depletion of wild races/demes. Recent broodstock collection activities have been reduced to lower the risk of depleting wild donor races/demes. However, captive-broodstock programs are currently being implemented to reestablish natural populations without needing to remove natural spawners from the system each year. The advantage of including a natural broodstock component to a hatchery program or establishing a captive-broodstock program is that they increase the number of returning adults, without overwhelming or replacing the natural gene pool.

Inadvertent artificial selection (domestication) can occur from a variety of hatchery practices that cause nonrandom mortality and selection, and where rearing and release strategies differ substantially from natural life-history patterns. Inadvertent selection can be avoided through implementation of strict mating and fertilization protocols, and by ensuring that hatchery fish are, qualitatively, as similar to naturally produced fish as possible (BPA et al. 1994a).

A number of hatchery practices can lead to loss of within-population variability. Broodstock selected for particular traits can lead to loss of traits that may have benefit to the wild gene pool. Examples of this include marked shifts in population run timing over several generations when broodstock is selected from one segment of the natural run cycle (Steward and Bjornn 1990). Loss of within-population variability can also occur where a disproportionate ratio of males are mated to females or the mating population is small. Current hatchery practices minimize these types of selections.

Loss of between-population variability can occur when broodstock is collected from locations that are remote to the targeted watersheds. In the past, non-indigenous stocks and hatchery derived stocks were commonly mixed. For genetic and fish health reasons, that practice has been discontinued and race/deme transfers are limited. Crossing of unrelated races/demes can also occur with high straying rates of hatchery fish into non-targeted streams (BPA et al. 1994c).

The majority of the above mentioned concerns regarding anadromous salmonid production operations are common to hatcheries throughout the Pacific Northwest. Significant improvements in hatchery practices have been instituted in PUD funded facilities. However, the influence of past hatchery practices in the basin is still evident in the depressed status of many wild fish populations. On-going efforts by the State and PUDs strive to minimize the deleterious effects of hatchery practices on wild populations and yet ensure a harvestable surplus of anadromous salmonids.

Predation

There is little available data to quantify direct predation of hatchery fish on wild fish, although as the size difference between hatchery and smaller wild fish increases, the predation potential is expected to increase. Salmonid predators are generally thought to prey on fish approximately 1/3 or less of their length (BPA et al. 1994c). Therefore, the predation of wild fish is expected to be greatest at the fry stage compared to smolts (USFWS 1994). This suggests that the greatest predation potential is expected to be from resident fish on the small wild fish that are displaced or drawn out of their natural rearing areas by the behavior and interactions with hatchery fish. The large number of hatchery fish in the system tends to support a correspondingly large population of predators. These predators are attracted to fish bypass outfalls or dam tailraces, where juvenile fish are more concentrated, and the resident predators might prey more heavily on the smaller wild fish (USFWS 1994).

3.2.5 ADULT SURVIVAL AT PROJECTS

3.2.5.1 Upstream Migration of Adults

Prior to dam construction, upstream migrating fish encountered rapids, chutes, and falls which were common in the Mid-Columbia River reach. The mainstem projects replaced the numerous natural gradient breaks with larger gradient breaks (i.e., the dams), interspersed with large pools (i.e., reservoirs). In order to pass fish over the dams, fishways were built at these dams. Although most salmon and steelhead successfully pass upstream over the projects, the PUDs continue to modify adult passage facilities to improve upstream passage conditions. Other fish species, including lamprey and sturgeon, do not pass through the fishladders as effectively (Hanson et al. 1992; BPA et al. 1994c).

Dam Passage

Three specific components of the adult migrations through the Mid-Columbia River corridor may affect anadromous fish species: delay at project fishways, passage success at project structures, and injuries and mortalities resulting from upstream and downstream passage through project facilities. Each of these components has the potential to increase pre-spawning mortality. For fish that do reach spawning areas, indirect effects associated with passage through multiple dams may reduce fecundity and reproductive success. Unfortunately, the relationship between each of these passage measures and reproductive success is not clearly understood.

Adult salmon and steelhead pass upstream through the Mid-Columbia River PUD dams via fishways installed at the projects. The fishways typically consist of an entrance gallery and ladder, a diffuser system that provides additional water at the ladder entrances (to attract fish from the tailrace), and a flow control section at the ladder exit that maintains ladder flow over varying forebay elevations. Observation areas have been established in each ladder to monitor upstream progress and the Wells and Priest Rapids dams have ladder traps for broodstock collection and monitoring. Migrational delays are most likely to occur at fishladder entrances, in the collection galleries, and during operation of the traps. Injury related to fish passage facilities is usually minimal, however system failures (especially at diffuser gratings in the entrance pools) can result in injury and mortality.

Assessments of the magnitude and effects of migratory delays at fishway facilities is complicated by the lack of information on the time required for adult anadromous fish to migrate through the unimpounded, natural reaches of the Mid-Columbia River. In addition, there are other environmental factors that influence migration in the Mid-Columbia River including hydrology, water temperature (in mainstem and tributaries), dissolved gas supersaturation, and turbidity (Dauble and Mueller 1993). Project operations (such as turbine and spill schedules) may also directly affect passage at these mainstem dams by increasing or decreasing the attraction of adults to the ladder entrances.

The impacts of delay vary by species, race/deme, and according to hydrologic and water quality conditions. Species such as spring-run (stream-type) chinook, summer-run (ocean-type) chinook salmon and steelhead that hold in the river for considerable periods prior to spawning are less likely to be negatively affected by slight to moderate delays at fishways (Meekin 1969). Late migrating species such as fall-run (ocean-type) chinook and sockeye salmon have a much shorter migratory “window” and may be more susceptible to the effects of delayed migration on pre-spawning mortality or spawning success (Meekin 1969).

Adult migration and passage rates are evaluated using radio-telemetry studies or comparisons of fish counts at the fishladders. However, these methods only provide information on how well radio-tagged fish pass from the tailrace of a specific dam into and through the fishway. The underlying assumption is that the behavior of radio-tagged fish is generally similar to untagged fish. Laboratory assessments of tagged and untagged fish and several years of field evaluations support this assumption, although little information is available regarding tagging effects on reproductive success. However, the radio-tagging studies are often unable to account for all the tagged fish. There is also no direct relationship between project passage times and reproductive success, although reducing passage time is generally believed to reduce energy expenditures and improve the likelihood of adult fish surviving to spawn.

The radio-telemetry evaluations can provide valuable information about specific areas within the fish collection and passage facility that appear to causing passage delays. However, only limited information can be obtained from fish that do not enter the system. Although the time it takes for fish to locate and enter the facilities can be quantified, it is extremely difficult to determine the causes of the delays. The delays may be the result of poorly designed passage facilities or factors related to either the operation of the passage facilities or the project as a whole. In addition, fish that fail to bypass a dam may be destined for a downstream spawning location or hatchery, or may have been affected by passage at downstream dams. The effects of the tagging process, as well as tag losses, can also affect the apparent conclusions of passage evaluations or the connection to reproductive success. The information can be used however, to assess the success of adult migrating upstream through the project area and to develop an index that can be used to assess improvements in passage conditions.

Stuehrenberg et al. (1995) conducted the only Mid-Columbia River evaluation that attempted to determine the eventual fate of all radio-tagged chinook salmon first detected downstream of the

Priest Rapids Dam. In this study, Stuehrenberg et al. (1995) estimated that the minimum survival rate of spring-run chinook salmon from the Priest Rapids Dam to the spawning grounds (or hatchery) was 77.8 percent. If all of the spring-run chinook salmon with unknown fates below the Priest Rapids Dam (N = 38) were fish from the Ringold Facility, the survival estimate would increase to 88.9 percent. In lieu of additional information specific to varying flow years or to steelhead, this assessment will be used as an estimate of total system effects in the interim period. As discussed above, it is not possible to differentiate natural effects from system-related effects at this time.

Wells Dam

The median project passage time for adult spring-, summer- and fall-run chinook salmon at the Wells Dam was 28.5, 46.9 and 45.7 hours, respectively, during a 1993 evaluation (Stuehrenberg et al. 1995). This study also noted that fish successfully passing the project moved directly into the collection channel from the tailrace with minimal delay. The majority of the passage delay identified in this study was associated with the collection channel itself. Of the 28.5 hour median project passage time for spring-run chinook salmon, over 90 percent, or 26.8 hours was spent attempting to negotiate the collection channel. Radio-telemetry evaluations conducted with summer-run chinook salmon in 1997 and 1998 demonstrated similar delay in the collection channel, although the influence of hatchery and natural production of summer-run chinook salmon downstream of Wells Dam is suspected to have affected the apparent results of these studies. Modifications to project operations, to reduce the apparent adult fish passage problems at Wells Dam, have been identified and implemented. Preliminary evaluations indicate that closing the side-gates to the ladder results in a substantial reduction in passage delay for summer-run chinook salmon. These results will be verified in 2001.

In 1997, passage times for spring- and summer-run chinook salmon, steelhead and sockeye salmon were 34, 41, 10, and 22 hours, respectively (Alexander et al. 1998). However, Swan et al. (1994) reported a substantially faster rate for sockeye salmon passing Wells Dam (5 hours). Similar project passage rates have been observed at other Mid-Columbia, Lower Columbia and Snake river dams (see Table 2-4).

These studies also estimated fallback rates at Wells Dam (see Table 2-4). The 1993 telemetry evaluation estimated a 3.6 percent fallback rate at Wells Dam for spring-run chinook salmon (2 of 56 radio-tagged spring-run chinook salmon). However, both of these fish were later detected in the Entiat River, suggesting that they may have inadvertently passed the project originally and the apparent fallback was a voluntary action. Alexander et al. (1998) report 2 of 7 spring-run chinook salmon (29 percent) and 1 of 20 steelhead fell back over Wells Dam in 1998 and did not reascend the ladders. Summer-run chinook salmon fallback surpassed 15 percent in 1997 and 1998 (English et al. 1998b; Nass et al. 1999), although the location of the summer-run chinook salmon hatchery and the known fall-run chinook salmon spawning areas downstream of Wells Dam suggest that some of the apparent fallback was voluntary. Sockeye salmon fallback was estimated at 3.5 percent in 1997 (English et al. 1998).

Alexander et al. (1998) also provided information on steelhead. Of the 20 radio-tagged steelhead that were detected at the Wells Dam, 16 fish (80 percent) successfully passed and remained above the dam during the study period. Of the four fish last located below the dam, 2 fish (10 percent) were last detected at the Wells Hatchery and 2 fish (10 percent) were last located in the tailrace. Alexander et al. (1998) reported that for the fish that successfully negotiated the dam, the median project passage time was 9.6 hours. Once upstream of the dam, the median migration rate to the Methow River 15.8 miles per day but only 4.5 miles per day to the Okanogan River. Only one fallback occurred during the study period and that fish never reascended the dam.

Although direct information is not available, it is reasonable to assume that adult survival during fallback and kelt (post-spawning steelhead) passage is much higher passing through the juvenile bypass system than through turbines.

Adult mortality can also be caused by delay at the Wells Dam. Although the delay at one dam, when considered in isolation, may not be significant, the cumulative delay at the nine passable dams on the Columbia River, may decrease spawning success. However, due to various factors (such as unknown losses caused by fisheries, tag loss or failure, fallback and tributary turnoff, and natural mortality rates) it is difficult to use the results of adult radio telemetry studies to estimate project specific mortality.

The NMFS (1998) assessed various radio-telemetry studies and concluded the average per-project mortality rates for upper Columbia River spring-run chinook salmon and steelhead passing the four lower Columbia River dams were 2.9 and 1.2 percent, respectively. These levels are within the range of estimates of natural mortality in other systems. Thus, it is not possible to differentiate between natural and hydrosystem caused mortality at this time.

Rocky Reach Dam

Median project passage times at the Rocky Reach Dam were estimated at 36.6 hours for adult spring-run chinook salmon, 22.9 hours for summer-run chinook salmon and 60.0 hours for fall-run chinook salmon (Stuehrenberg et al. 1995) (see Table 2-4). English et al. 1998c estimated a median passage time of 26 hours for radio tagged steelhead that successfully passed the project (22 fish). These median passage times are similar to those recorded for sockeye and summer-run chinook salmon (36 and 30 hours, respectively), which were based on between 103 and 249 fish detected at Rocky Reach (English et al. 1998c).

English et al. (1998c) also noted that no spring-run chinook salmon and only 1 steelhead (5 percent) fell back over the Rocky Reach Dam in 1997, although the sample sizes were very small (see Table 2-4). As a comparison, the fallback rates for summer-run chinook and sockeye salmon were 2 and 14 percent, respectively. It is unclear if the fish fell back through the powerhouse or over the spillway. Spill at the Rocky Reach Dam was higher in 1997 than during the 1993 telemetry evaluation but the number of summer-run chinook salmon that fell back over the dam were comparable between years. The fallback rate was much higher for sockeye salmon in 1997 than in 1993 (14 percent).

The observed adult fish passage times at Rocky Reach are similar to those at other Mid-Columbia River Dam. Although any delay related to passage at one dam when considered in isolation may not be significant, the cumulative delay at nine dams on the Columbia River likely decreases spawning success. Issues currently identified for adult chinook salmon and steelhead that may affect injury and delay include entrance into the fishladders from the tailrace, passage in the junction pool between the fishway entrances and the ladder, large tailwater fluctuations that impact fishway operations, and fallback.

As discussed above, the various uncertainties related to radio-telemetry data make it difficult to estimate project specific mortality. The level of uncertainty associated with these data is substantial; documented fallback, delay, and unaccounted loss below the project indicates that adult passage problems may be occurring at the Rocky Reach Dam. Chapman et al. (1994a, 1994b and 1995a) estimated average mortality rates for all the Mid-Columbia River dams at 5 percent for summer/fall-run chinook salmon, 4 percent for steelhead, and 2 to 6 percent for spring-run chinook salmon. The average per dam mortality rate estimated for upper Columbia River spring-run chinook salmon and steelhead passing the Federal hydroelectric projects on the lower Columbia River is 2 percent (NMFS 1998). As discussed above however, it is not possible to differentiate natural effects from system-related effects at this time.

Approximately 236 steelhead kelts were observed in the juvenile bypass system in 1998. Although direct information is not available, it is reasonable to assume that adult survival during fallback and kelt passage is higher passing through the juvenile bypass system than through turbines. Although the bypass is not specifically operated throughout the entire adult and kelt passage seasons, it provides some protection to these fish when it is operated. Adult passage through the spillway is also assumed to be safer than turbine passage.

Rock Island Dam

Median project passage times at the Rock Island Dam were 20 to 39 hours for adult spring-run chinook salmon and 4 hours for steelhead during the 1993 and 1997 radio-telemetry evaluations (Stuehrenberg et al. 1995; English et al. 1998c). However, these estimates are based on very small sample sizes. Of the 680 spring-run chinook salmon and 975 steelhead tagged at the Bonneville Dam in 1997, only 12 chinook salmon and 25 steelhead were detected at the Rock Island Dam. Median passage times for summer-run chinook and sockeye salmon in 1997 were 15 and 17 hours, respectively (see Table 2-4).

The sample sizes obtained in 1993 for sockeye and summer-run chinook salmon were large enough to identify potential problem areas in the adult fishways. Although the data is not absolutely clear, delay locating the fishway entrances and delays at the junction pool areas below the ladders account for the largest percentage of the passage times.

English et al. (1998c) noted that no spring-run chinook salmon, 3 summer-run chinook salmon (2 percent), 12 sockeye salmon (4 percent) and one steelhead (4 percent) fell back over the Rock Island Dam in 1997 (see Table 2-4). It is unclear if the fish fell back through the powerhouse or over the spillway, although spill was occurring at the time. Fallback at lower Columbia River dams has ranged from 2 to 14 percent and at Snake River dams from 4 to 18 percent (Chapman et al. 1995a).

Because of uncertainties with the radio-tagging study results, it is not possible to accurately determine mortality rates, nor is it possible to differentiate natural effects from project effects.

3.2.6 Juvenile Survival at the Projects

Dam structures form a physical barrier in the path of fish migrating downstream. Mechanisms that allow fish to pass from the upstream to the downstream side of any dam are:

- passage through a turbine;
- passage over a spillway or through a sluiceway;
- passage through a juvenile bypass system;
- passage in a downstream direction through ancillary dam facilities, such as the adult fishway facilities; or
- collection of fish on the upstream side of the structure followed by transport and release on the downstream side.

Potential impacts resulting from any project passage route can be categorized as either a direct or indirect effect. Direct effects are a consequence of physical injuries that may be incurred during passage through spillway, sluiceway, or turbine structures. Direct effects may result in immediate or delayed mortality (Chapman et al. 1994a). Indirect effects result from debilitated, disoriented, or stunned juvenile fish being exposed to additional sources of mortality such as predation (Chapman et al. 1994a).

3.2.6.1 Turbine Passage

Direct mortality occurs within the confines of a turbine. Based on inferential data and knowledge of turbine conditions, it is assumed that direct mortality can originate from mechanical, pressure or hydraulic-related factors. Mortality due to mechanical factors may result from fish striking the blades or passing through gaps between turbine components. Pressure or hydraulic-related mortality probably occurs as fish pass through areas of cavitation, hydraulic shear or other areas where pressure or velocity change may cause injury or death (Normandeau and Skalski 1997).

Indirect mortality occurs after fish, particularly juvenile fish, have left the turbine. The principal cause of indirect mortality of juvenile fish is likely predation by fish or birds (Poe and Rieman 1988). This most likely occurs in the tailrace as the juveniles recover from the disorientation and stress of turbine passage (Ledgerwood et al. 1990). Passage may also create harmful levels of physical or behavioral stress, leading to a weakened resistance to disease and subsequent delayed mortality (Ferguson 1994).

Estimates of turbine mortality in other Columbia River basin projects vary from 2 to 19 percent (Whitney et al. 1997). The average survival rate reported from direct recapture studies is 94.5 percent. In tests that included some level of indirect mortality (including predation on disoriented fish), the survival levels averaged 89.1 percent (Whitney et al. 1997). However, these average estimates include some data collected prior to the implementation of predator abatement programs, as well as for older (less efficient) turbine units. More recent evaluations, conducted under turbine operations presumed to provide the best passage conditions for fish (i.e., within 1 percent of peak efficiency), indicate greater survival rates. Turbine survival studies in the Snake River between 1993 and 1997 indicate an average turbine survival rate of about 91.2 percent (NMFS 2000).

Wells Dam

Approximately 8 percent of the juvenile salmon and steelhead migrants pass through the turbines at the Wells Dam (Skalski 1993). However, no specific estimates of turbine passage survival exist at the Wells Dam following improvements made to the turbine units in the late 1980s, or after implementing predator abatement programs. Therefore, the 91.2 percent average survival level in recent studies on the Snake River is expected to best represent the current passage conditions through turbine units at the Wells Dam (NMFS 2000).

Rocky Reach Dam

The direct survival of chinook salmon smolts passing through the Kaplan turbines at the Rocky Reach Dam was assessed during two balloon-tag studies. The 1993 study estimated passage survival at 94 percent (RMC Environmental Services and Skalski 1994). The 1996 tests measured survival rates of 95 percent for a new turbine unit (Unit 6) and 96 percent for an original Kaplan turbine (Unit 5) (Normandeau and Skalski 1996).

The PUD has begun a multi-year process to install new turbines across the powerhouse. These replacement turbines are designed to reduce the gap between the blade and runner that is considered to be one cause of direct turbine mortality. Also, the new turbines have a higher efficiency rating than the original turbines. Fish passage survival is generally considered higher for more efficient turbines and operations at peak turbine efficiency (Bell 1981). There are no comparatively unique features at the Rocky Reach Dam that would indicate significantly different levels of indirect mortality compared to other facilities. Therefore, the 91.2 percent survival rate discussed above likely represents turbine passage survival for all species at the Rocky Reach Dam.

Based on juvenile radio-telemetry evaluations conducted in 1998, approximately 49 percent of the radio-tagged steelhead and 61%[1] of the radio-tagged spring-run chinook salmon passed the project via the powerhouse (English et al. 1999). In 1999,

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[1] Radio-tagged fall chinook obtained from the East Bank Hatchery had considerably higher powerhouse passage rates in 1997 and 1998 (e.g., approximately 81% powerhouse passage in 1998 [English et al. 1998]). It is unclear at this time why the *naive* hatchery fish passed the project via the powerhouse at significantly higher rates than the *experienced* fish trapped at the surface bypass system and then released back upstream of the project.

Lady et al. (2000) estimated that approximately 28% of the radio-tagged steelhead passed the project via the powerhouse and English et al. (1999) estimated that 58 and 40 percent of the radio-tagged spring-run chinook salmon and steelhead passed the project via the powerhouse, respectively. Normandeau and Skalski (1996) estimated that the direct survival of balloon-tagged fall-run chinook salmon passing through the old Kaplan units ranged from 91.3 percent to 98.7 percent (weighted average = 95.8 percent), and ranged from approximately 88.8 to 97.2 percent (weighted average = 95.0 percent) for the newly rebuilt Kaplan units. Survival through the fixed blade units for balloon-tagged hatchery reared fall-run chinook salmon ranged from 91.7 to 100.0 percent [weighted average = 96.1 percent (RMC and Skalski 1994)].

The most significant difference between the balloon-tag evaluations conducted in 1993 and 1996 had to do with operation of the test units. In 1993, the units had no restrictions and were operated as needed to meet load. In 1996, load was kept at a constant throughout the test. This may help explain the variability seen in the results between the two years, and may better indicate the range of possible survival levels during normal turbine unit operations. Although neither evaluation was able to discern the indirect effects associated with powerhouse passage, the pilot level survival evaluation conducted using radio-tagged steelhead in 1999 estimated direct and indirect survival at 89.7 percent (Lady et al. 2000), suggesting that the indirect effects associated with turbine passage are more significant than those seen at the bypass system or spillway.

Rock Island Dam

Between approximately 70 and 75 percent of the juvenile upper Columbia River spring-run chinook salmon and steelhead pass through the turbines at the Rock Island Dam (Iverson and Birmingham 1998; Lady et al. 2000). Normandeau and Skalski (1997) estimated the direct survival of fall-run chinook salmon passing through the bulb turbines and Kaplan-type turbines at 95.7 and 96.1 percent respectively. Direct survival through the Nagler turbines at Powerhouse One was somewhat less, estimated at 93.2 percent. Unfortunately, none of these route specific estimates account for indirect survival, which has yet to be evaluated with proven technologies.

Specific features of the bulb turbines, including the horizontal discharge from an extended draft tube, which significantly reduces the backroll typical of Kaplan-type turbine units, and the limited amount of cavitation associated with bulb turbine operations, may result in the safest downstream conditions for juvenile upper Columbia River spring-run chinook salmon and steelhead. These attributes may reduce indirect, stress related injuries or mortality and may further reduce predation in the tailrace. Therefore, juvenile salmonids passing the project through powerhouse two may have a lower associated indirect mortality than juvenile salmonids passing through Powerhouse One. In fact, evaluations conducted in 1999 (Stevenson et al. 2000) indicated that over 65 percent of the radio-tagged, hatchery reared juvenile steelhead passed the project via Powerhouse Two at a significantly higher survival rate than that estimated for Powerhouse One. Although using radio telemetry techniques to assess survival has yet to be satisfactorily, independently verified, as discussed earlier, the results do support these initial conclusions.

3.2.6.2 Spill Passage

Survival of fish passing through spillways of dams on the Columbia River has been estimated at between 98 and 100 percent (Anderson et al. 1993; Whitney et al. 1997). In the absence of project specific data, these estimates are considered the best available estimates of spill passage survival.

Wells Dam

Five of 11 spill bays at the Wells Dam have been modified to function as a juvenile bypass system.

These modifications increase water velocities to attract surface oriented fish, which are then bypassed through the spillway. Detailed discussions of the Wells Dam bypass are provided in the Section 3.2.6.3 (Juvenile Bypass Systems).

Rocky Reach Dam

At the Rocky Reach Dam, the Chelan County PUD provides up to 36 days of spill during the spring migration period, with an additional 6 days of spill (if necessary) to cover the middle 90 percent of the Okanogan sockeye salmon outmigration. Spill is provided at a level of 15 percent of the previous days average flow - distributed over a 24-hour period. Information acquired over the past 4 years, indicates that the middle 95 percent of the spring-run chinook salmon and steelhead outmigrations range from 30 to 48 days at the Rocky Reach Dam, averaging 42 days for steelhead and 41 days for spring-run chinook salmon (Chelan County PUD 2000). Hydroacoustic studies conducted over several years at the Rocky Reach Dam have shown that an average of 8 percent of the spring migrating smolts pass through the spillway in 15 percent spill (Steig and Adeniyi 1997). However, similar spill levels in 1998 and 1999 resulted in an average passage rate of 12.3 percent for spring-run chinook salmon and steelhead (English et al. 1998, 1999). During the summer, the Chelan County PUD spills 10 percent of the previous days average flow for a total of 34 days between June 15 and August 15.

Only one estimate of spillway survival exists for the Rocky Reach Dam, and that was estimated with coho salmon through a single spill bay in 1980 (Heinle and Olson 1980). The results of this evaluation indicated that survival may be comparatively high, approximately 99 percent. Whitney et al. (1997) also reviewed several spillway survival studies in the Columbia River basin and concluded that spillway survival is typically ≥ 98 percent. This estimate is supported by the 99 percent spillway survival estimate for coho salmon at the Rocky Reach project. In lieu of additional species specific information however, the 98 percent average calculated by Whitney et al. (1997) is assumed for the remaining Plan species bypassing the Rocky Reach spillway.

Rock Island Dam

Although the preferred method for increasing juvenile passage survival at the Rock Island Dam is through the use of spill, discharge has been limited because of funding limitations in the conservation account ($2.05 million annually at the market price of energy) and due to total dissolved gas production. In an effort to increase spill efficiency, the PUD has modified 10 of the 33 spill gates to allow for more surface oriented spill. The modified surface spill gates, or notched gates, utilize a maximum of approximately 2,000 cfs per spill bay and have been found under certain conditions to pass comparatively more fish per volume of water than the existing spill bays (Ransom and Steig 1995).

During the 1998 spring migration, the Chelan County PUD spilled approximately 25 percent of the total river flow for fish passage on a 24-hour basis. At this spill level, both the modified surface spill gates and several of the unmodified spill bays were utilized. Hydroacoustic studies estimated that approximately 27 percent of the yearling chinook salmon and 26 percent of the juvenile steelhead passed through the spillway in 1998 (Iverson and Birmingham 1998). Radio telemetry evaluations estimated that 28.5 percent of steelhead smolts passed the project through the spillway in 1999 (Lady et al. 2000).

Direct survival estimates through particular spill bays for hatchery reared chinook salmon were calculated in 1997 by Normandeau and Skalski (1998). The direct survival through the notched weirs was estimated at 95.1 percent and the direct survival through the unmodified spill bays was estimated at approximately 98.4 percent.

Normandeau and Skalski (1998) concluded that the reduced survival levels calculated through the notched weirs may have resulted from the associated shallow stilling basin at bay 21, and the reduction in discharge through the notched weirs. They also noted that the 1,000 cfs of water discharged through the notched weirs had a much more pronounced plunge than the shallower, downstream projection of the 10,000 cfs discharged through the unmodified spill bay. A subsequent survival study estimated survival through both modified and unmodified spillways at between 99.5 and 100 percent (Normandeau Associates 1999).

Given the configuration of the Rock Island spillway (i.e., no downstream ogee, plunging flow), it is probable that some level of indirect mortality occurs in the tailrace, but there is not adequate data for accurate estimates.

3.2.6.3 Juvenile Bypass Systems

Estimates of the direct survival rate of juvenile salmon and steelhead through bypass systems includes mortality rates associated with turbine intake screens, gatewells, orifices, bypass flumes, dewatering screens, sampling facilities (including holding tanks), and bypass outfall conduits. Estimates of direct bypass mortality found at sampling facilities for the bypass systems at the Federal hydroelectric projects on the Snake and lower Columbia rivers suggest that the direct mortality of both wild yearling steelhead and chinook salmon is generally less than one percent (Martinson et al. 1997; Spurgeon et al. 1997; summarized in NMFS FCRPS Supplemental Biological Opinion 1998), although some level of stress or injury may result in mortality later in the life cycle. Bypass survival may also be indirectly affected by predation at poorly located outfall sites or by delayed mortality associated with injury caused by the bypass system. Bypass system outfalls that concentrate juvenile salmon and steelhead into a comparatively small volume of water may cause high levels of predation related mortality.

Wells Dam

Hydroacoustic studies conducted from 1990 through 1992 at Wells Dam estimated that 92 percent of the spring outmigrants (which include steelhead, spring-run chinook and sockeye salmon) were guided through the juvenile bypass system (Skalski 1993). These estimates have been supported by similar information collected during concurrent fyke net evaluations (Bickford 1997). A juvenile chinook salmon balloon-tag study that was conducted in 1993 concluded that there was no measurable direct injury or mortality through the bypass system (RMC Environmental Services, Inc. 1993).

Although this study did not measure the effect of predation in the tailrace on juveniles disoriented or stressed from passage through the bypass system, juveniles are not concentrated in reduced flow in a particular area of the tailrace. Therefore, predation of bypassed smolts in the tailrace may be lower than other bypass systems that have concentrated outfall locations that tend to attract predators. In addition to the potentially reduced predation rates, the limited spill volumes required by the bypass system minimizes the total dissolved gas levels downstream. However, in the absence of specific evaluations of indirect mortality rates at the Wells Dam, the total direct and indirect mortality is assumed to be similar to the 2 percent found at the lower Snake River project bypass systems (NMFS Federal Columbia River Power System, Supplemental Biological Opinion 1998a).

The PUD operates the bypass system 24 hours a day throughout the period it takes at least 95 percent of the juvenile spring migrants to pass the Wells Dam. The Wells Coordinating Committee bypass team determines the operation dates for the Wells bypass system by utilizing monitoring information from hydroacoustic transducers installed in the forebay of the Wells Dam.

Rocky Reach Dam

The juvenile bypass system currently under development at the Rocky Reach Dam includes two surface collection entrances and intake guidance screens in turbine units one and two. Passage efficiency tests conducted in 1998 showed that approximately 41 percent of the radio-tagged yearling chinook salmon and 51 percent of the PIT-tagged steelhead passed the project via this route (English et al. 1998a). The guidance efficiency levels for steelhead and chinook salmon were an improvement to those achieved in 1997 with only one collector entrance in operation. Passage efficiencies in 1999 were estimated at 53 percent for steelhead, 32 percent for chinook salmon, and 11 percent for sockeye salmon (Mosey et al. 2000). Radio telemetry evaluations in 1999 also indicated that about 57 percent of steelhead passed the project through the bypass. However, the passage efficiency of the bypass is influenced by the proportion of fish that pass the project through the spillway before they reach the area of influence of the bypass. The combined spillway and bypass efficiencies in 1998 and 1999 were between 49 and 50 percent for yearling chinook salmon, and between 62 and 64 percent for steelhead (Lady et al. 2000).

In both the 1997 and 1998 evaluations however, there were significant differences noted between passage efficiency rates of *naïve* hatchery chinook (chinook salmon previously unexposed to the bypass system) and run-of-river chinook salmon captured in the bypass system then tagged and released back upstream for evaluation. In 1998, the bypass efficiency for naïve chinook salmon was substantially lower (19 percent) than those that had previously entered the bypass system (41 percent) (English et al. 1998a). It is unknown at this time which population more accurately represents the run at large. Therefore, both estimates are considered in the efficiency estimates.

Information reported by English et al. (1998a) states that increasing efficiency in one area of the bypass system would likely decrease efficiency in another area of the system. This has already been demonstrated to a degree through comparisons of the existing data. As a result, the total number of chinook salmon and steelhead outmigrants available for collection and passage via this bypass route may be limited.

To determine the rate of injury that may be caused by the bypass system at Rocky Reach, samples of yearling chinook salmon, selected to preclude prior injury, have been released into the surface collector and turbine intake systems and subsequently captured and reexamined for injury. These tests have shown descaling and injury rates attributable to passage through the downstream collection entrance were generally less than 2 percent (Peven et al. 1995, 1996; Peven and Mosey 1998). In 1998 however, 4.4 percent of yearling chinook salmon released into the upstream collector entrance had significant scale loss or injury (Mosey et al. 1999). In 1999, by improving hydraulic conditions in turbine intakes and at the fish diversion screens of units one and two, the PUD expects to improve fish passage conditions, and thereby reduce this scale loss and injury rate. Under the assumption that the injury rate can be reduced to nearly zero for the 2000 migration, it is unlikely that additional mortality will result from stress due to injury.

No measurements of indirect mortality are available to determine the survival of smolts after they pass through the bypass outfall pipe. Studies of subyearling chinook salmon bypass mortality at Bonneville Powerhouse 1 and Powerhouse 2 (Ledgerwood et al. 1990, 1994; Dawley et al. 1996) indicate that high bypass mortality may be associated with predation that occurs at a poorly-sited bypass outfall. The temporary bypass outfall site, located in front of the turbine unit four upwelling, was not situated using the current knowledge of predator behavior (e.g., Loch et al. 1994; Mesa and Olson 1993). Therefore, predation mortality may be significant at the temporary site.

However, the PUD has implemented measures to reduce indirect mortality caused by predation in the tailrace. Gull hazing by propane cannons and gull wires across the tailrace reduces gull predation on smolts. Also, the PUD will continue the northern pikeminnow removal program which has removed more than 4,000 predators annually from the tailrace since 1994 (Chelan County PUD 1999b). With improved hydraulic conditions at the intake screens, and with a properly sited bypass outfall, survival through the Rocky Reach bypass system is expected to equal the 98 percent survival rate estimated for bypass systems at the lower Snake River dams.

Rock Island Dam

Powerhouse 2 is equipped with a passive bypass system (no intake screens for guidance) that allows fish to voluntarily enter turbine unit gatewells and exit them via bypass orifices to a collection channel that leads to a fish sorting collection raceway. The annual passage of juvenile spring-run chinook salmon through this system has ranged from 8,500 to 33,500 from 1985 to 1996 (Fish Passage Center, Annual Reports 1985 – 1996). Although the percentage of the total population is small, this facility provides useful monitoring information for upper Columbia River fish stocks. Due to the small numbers of fish using this system, survival rates are not known.

3.2.6.4 Total Project Survival – Juvenile Migrants

Total project survival for juvenile migrants is defined as the percentage of fish that survive through the reservoir, forebay, dam and tailrace of an individual project. The preferred method for estimating total project survival is through mark and recapture studies that compare the survival of a test group of fish released at the head of the reservoir with a control group of fish released in the project tailrace (i.e., a measured survival estimate).

Unfortunately, methodologies do not currently exist to measure total project survival for all species. The number of fish available, the size, health and vulnerability of the fish during their outmigrations, and the detectability of certain species at downstream collector sites all affect the feasibility of utilizing mark and recapture techniques. As an alternative, survival estimates measured for certain species through a particular passage route can be combined with estimates of fish passage efficiency for other species where survival information is unknown to calculate an estimate of dam passage survival (i.e., a calculated survival estimate). Although these estimates do not include tailrace or reservoir survival, or estimates of indirect survival, they can be used to generally identify expected dam passage survival if other information is unavailable.

This section discusses the results of estimating total project survival for juvenile salmon and steelhead under both techniques at each of the projects, in an attempt to determine the overall range of expected survival. Because of the specific assumptions required for each methodology, varying environmental conditions, and the annual and behavioral differences in each of the species, these estimates tend to vary by year, by species, and by estimation technique. In addition, the majority of the available information was developed specifically for yearling spring-run chinook salmon and steelhead. This information is generally assumed to represent other salmon species where specific information is unavailable, pending additional studies specific to those fish.

The cumulative effects (i.e., the effects of multiple dam passage on juvenile fish) are not clearly accounted for with either methodology.

Wells Dam

Juvenile survival through Wells Dam is considered to be high when compared to other dams on the Columbia and Snake rivers. This is due to its highly effective bypass system (passing 92 percent of the juveniles) and the apparently high survival through that route (likely above 98 percent). Multiplying the estimated passage rate (92 percent) of the bypass system by the estimated survival rate (98 percent) indicates that 90.2 percent of the juveniles passing Wells Dam survive through this passage route (Table 3-3). The remaining 8 percent of the spring

TABLE 3-3. JUVENILE FISH SURVIVAL ESTIMATES

		Estimated Survival Through Individual Passage Routes[1]							
	Species	Spillway Passage (%)	Spillway Survival (98%)	Bypass Passage (%)	Bypass Survival (98%)	Turbine Passage (%)	Turbine Survival (91.2%)	All Routes Combined– Total Survival (%)	Survival Studies – Total Project Survival (%)
Wells Dam									
1998	Spring Chinook	NA	NA	92	90.2	8	7.3	**97.5**	**99.7**
	All Other Species	NA	NA	92	90.2	8	7.3	**97.5**	**NA**
1999	Steelhead	NA	NA	92	90.2	8	7.3	**97.5**	**94.3**
	All Other Species	NA	NA	92	90.2	8	7.3	**97.5**	**NA**
Rocky Reach Dam									
1998	Chinook (in-river)	8	7.8	41	40.2	51	46.5	**95.4**	**NA**
	Chinook (Hatchery)	8	7.8	19	18.6	73	66.6	**93.0**	**85.9**
	Steelhead	14	13.7	52	51.0	34	31.0	**94.5**	**NA**
	Sockeye	23	22.5	10	9.8	67	61.1	**92.5**	**NA**
1999	Spring Chinook	18	17.6	32	31.4	50	45.6	**94.7**	**NA**
	Summer Chinook	8	7.8	50	49.0	42	38.3	**95.1**	**NA**
	Steelhead	9	8.8	53	51.9	38	34.7	**95.3**	**95.9**
	Sockeye	19	18.6	15	14.7	66	60.2	**93.5**	**NA**
Rock Island Dam									
1998	Chinook (in-river)	27	26.5	NA	NA	73	66.6	**93.1**	**NA**
	Steelhead	26	25.5	NA	NA	74	67.5	**93.0**	**NA**
	Sockeye	20	19.6	NA	NA	80	73.0	**92.6**	**NA**
	Coho	35	34.3	NA	NA	65	59.3	**93.6**	**NA**
	Fall Chinook	33	32.3	NA	NA	67	61.6	**93.9**	**89.3**
1999	Steelhead	28.8	27.9	NA	NA	72	65.3	**93.2**	**95.8**

[1] Based on assumed survival and passage rates through the available passage routes at Wells, Rocky Reach and Rock Island dams, along with specific total project (reservoir and dam passage) survival estimates based on tagging studies.

NA = Not available.

migrants pass through the turbines with an estimated 91.2 percent survival rate (based on turbine operations at maximum efficiency), resulting in an estimate of 7.3 percent juvenile survival through the Wells turbines. Adding 7 percent turbine survival to the 90.2 percent bypass system survival results in a total juvenile survival rate of approximately 97.5 percent. Survival rates are expected to vary to a degree by species and by year (due to differences in water and fish conditions etc).

This estimated survival rate is also similar to the average survival estimates obtained from recent PIT-tag studies that also included survival through the Wells Dam reservoir. Bickford et al. (1999) report a survival rate of 99.7 percent for PIT-tagged chinook salmon from the Methow River to below the dam. By factoring out the 97.5 percent dam passage survival estimate, the resulting point estimate for reservoir survival rate was 100.2 percent. A similar study with steelhead in 1999 estimated a reservoir and dam passage survival rate of 94.3 percent (Bickford et al. 2000. The juvenile dam passage survival rate estimates are greater than the 95 percent juvenile dam passage survival goal established in the HCP, although additional survival estimates would be needed to verify that these preliminary estimates are appropriate for all Plan species, and over varying river flow conditions.

Rocky Reach Dam

Based on the available information, approximately 11 to 51 percent of the juvenile fish pass the dam through the prototype bypass system (see Table 3-3). An estimated 8 to 23 percent of juvenile fish pass through the spillway. This leaves approximately 39 to 73 percent of juvenile fish to pass through the turbines.

Multiplying the bypass passage rate estimates by the 98 percent bypass survival rate results in 10.8 to 50 percent of all juvenile fish passing the project surviving through the bypass system. Multiplying the 8 to 23 percent spill passage rate by the 98 percent spill survival rate results in 7.8 to 22.5 percent overall survival through the spillway. Multiplying the turbine passage rates by the 91.2 percent turbine survival rate results in about 36 to 67 percent of smolts surviving through the powerhouse. Adding the survival through the three routes indicates approximately 93 to 98 percent dam passage survival (see Table 3-3). These estimates are similar to PIT-tag and radio-tag survival studies conducted in 1999 with hatchery reared yearling fall-run chinook salmon, which suggest project survival rates (reservoir and dam passage) of 96 to 97 percent (Bickford et al. 1999; Eppard et al. 1999).

Similar to the survival estimates for Wells Dam, these estimates suggest that survival rates are close to the standards established in the HCP, although some additional protection measures might be needed to meet the standards for all of the Plan species. As with the estimates for Wells Dam, additional studies are needed to verify that these estimated Rocky Reach survival rates are accurate and that they are appropriate for all the Plan species, over varying river flow conditions.

Rock Island Dam

Based on available information, approximately 65 to 80 percent of the juvenile outmigrants will pass the Rock Island Dam via the powerhouses and about 20 to 35 percent will pass via the spillway (see Table 3-3). Under the current operating conditions, the estimated spillway survival rate is about 98 percent. Multiplying the spillway passage rate by the spillway survival rate results in 20 to 34 percent of smolts surviving through the spillway. The estimated smolt survival rate through the Rock Island turbines is 91.2 percent. Multiplying the turbine passage rate by the estimated turbine survival rates results in 59 to 73 percent survival through the turbines. Adding spill and powerhouse survival results in approximately 92 to 94 percent survival through the dam and tailrace at Rock Island Dam (see Table 3-3). The overall average for all species is about 93.2 percent survival, which is within the range of estimates obtained through tagging studies (85 to 99 percent), which includes reservoir and dam passage (Bickford et al. 1999; Eppard et al. 1999).

These estimates indicate that additional protection measures would likely be required to achieve the 95 percent juvenile dam passage survival goal established in the HCP for all Plan species. As discussed above, additional studies are needed to verify that these estimated Rock Island survival rates are accurate and that they are appropriate for all the Plan species, over varying river flow conditions.

3.2.7 OVERALL FISH PASSAGE SURVIVAL

The HCPs establish an overall survival rate goal of 91 percent for adult and juvenile passing the Mid-Columbia River projects. At this time however, there is no information specific to the survival of adult salmon or steelhead available for the Mid-Columbia River projects. Based on the small amount of information that is available, the average survival of adult spring-run chinook salmon and steelhead is estimated at between 77.8 percent and 88.9 percent for the entire Mid-Columbia River reach (from below the Priest Rapids Dam to the known spawning areas). The percentage of the associated mortality attributable to the individual projects is unknown.

It is currently not possible to determine whether the observed mortality rates are within the range of natural mortality, or whether survival is affected by the operation of the hydroelectric projects. The species characteristics that define the Columbia River salmon and steelhead make comparisons with other river systems problematic and unreliable. In addition, the effects of dam passage on spawning success are unknown.

As a result of these uncertainties, it is not possible to estimate the overall fish passage survival rates at the present time.

3.2.8 RESIDENT FISHERY RESOURCES

Resident fish resources in the Mid-Columbia River have not been studied extensively, but some information on species composition and abundance is available (Table 3-4). Dell et al. (1975) report the most abundant resident fish species were northern pikeminnow (*Ptychocheilus oregonensis*), stickleback (*Gasterosteus aculeatus*) and suckers (*Catostomus* sp.). They also determined that whitefish and pumpkinseed (*Lepomis gibbosus*) were the most abundant resident game fish, although these species accounted for less than 2 percent of the total 32,289 fish sampled. Based on fishladder observations, Mullan et al. (1986) found that resident salmonids and white sturgeon (*Acipenser tranmontanus*) were scarce, and that the fish community was dominated by stickleback, minnow (*Cyprinidae*), and suckers. Known life-history characteristics of the resident fish species in the Mid-Columbia River basin are provided below.

3.2.8.1 Life Histories

Westslope Cutthroat Trout

Westslope cutthroat trout are allopatric with rainbow trout, and have similar life histories. They are chiefly distributed in upper reaches of east slope Cascade range tributaries, including the Wenatchee, Entiat, and Methow rivers and typically do not occur in the mainstem reservoirs. Many of these cutthroat trout show some degree of hybridization with rainbow trout. Westslope cutthroat trout exhibit adfluvial and fluvial life-history strategies. Their habitat requirements are similar to that of both rainbow trout and bull trout (Behnke 1992). Cutthroat and rainbow trout spawn at the same time and place, and considerable hybridization results when hatchery-produced rainbow trout are stocked in streams with natural cutthroat trout (Simpson and Wallace 1982).

TABLE 3-4. OTHER FISH SPECIES THAT MAY OCCUR IN THE COLUMBIA RIVER SYSTEM

SCIENTIFIC NAME	COMMON NAME	PRESENCE IN PLAN AREA	STATUS	REFERENCE
Lampetra tridentata	Pacific lamprey	A, B, C	native, common	Wydoski and Whitney 1979
Lampetra ayresi	river lamprey	A, B, C	native, unknown	Wydoski and Whitney 1979
Acipenser transmontanus	white sturgeon	A, B, C	native, common	BPA et al. 1994b
Prosopium williamsoni	mountain whitefish	A, B, C	native, common	Dell et al. 1975; Army Corps of Engineers 1994
Prosopium coulteri	pygmy whitefish	A, B, C	native, rare	BPA et al. 1994b
Salmo trutta	brown trout	A, B, C	introduced, rare	Wydoski and Whitney 1979
Oncorhynchus clarki	cutthroat trout	A, B, C	native, common	Wydoski and Whitney 1979
Oncorhynchus nerka	kokanee	A, B, C	native, common	Dell et al. 1975
Oncorhynchus mykiss	rainbow trout	A, B, C	native, common	Wydoski and Whitney 1979
Salvelinus fontinalis	eastern brook trout	A, B, C	introduced, rare	Wydoski and Whitney 1979
Salvelinus confluentus	bull trout	A, B, C	native, uncommon	Dell et al. 1975; Wydoski and Whitney 1979
Salvelinus namaycush	lake trout	A, C	introduced, rare	Wydoski and Whitney 1979
Cyprinus carpio	carp	A, C	introduced, common	Dell et al. 1975; Wydoski and Whitney 1979
Tinca tinca	tench	A, C	introduced, uncommon	Dell et al. 1975; Wydoski and Whitney 1979
Acrochelius alutaceus	chiselmouth	A, B, C	native, abundant	Dell et al. 1975
Richardsonius balteatus	redside shiner	A, B, C	native, abundant	Dell et al. 1975; BPA et al. 1994b
Rhinichthys cataractae	longnose dace	B	native, common	Wydoski and Whitney 1979
Rhinichthys falcatus	leopard dace	A, C	native, common	Wydoski and Whitney 1979
Rhinichthys osculus	Speckled dace	B	native, common	Wydoski and Whitney 1979
Ptychocheilus oregonesis	northern pikeminnow	A, B, C	native, abundant	Burley and Poe 1994
Mylocheilus caurinus	peamouth	A, B, C	native, common	Dell et al. 1975
Couesius plumbeus	lake chub	A, B, C	native, abundant	Wydoski and Whitney 1979
Catostomus catostomus	longnose sucker	A, B, C	native, common	Wydoski and Whitney 1979
Catostomus macrocheilus	largescale sucker	A, B, C	native, abundant	Wydoski and Whitney 1979
Catostomus platyrhynchus	mountain sucker	A, B, C	native, common	Wydoski and Whitney 1979
Catostomus columbianus	bridgelip sucker	A, B, C	native, abundant	Wydoski and Whitney 1979
Ictalurus punctatus	channel catfish	A, B, C	introduced, common	Wydoski and Whitney 1979
Amiurus nebulosus	brown bullhead	A, B, C	introduced, common	Wydoski and Whitney 1979

TABLE 3-4 OTHER FISH SPECIES THAT MAY OCCUR IN THE COLUMBIA RIVER SYSTEM (CONTINUED)

SCIENTIFIC NAME	COMMON NAME	PRESENCE IN PLAN AREA	STATUS	REFERENCE
Amiurus melas	black bullhead	A, B, C	introduced, uncommon	Dell et al. 1975; BPA et al. 1994b
Lota lota	burbot	A, C	native, rare	Wydoski and Whitney 1979
Gasterosteus aculeatus	three-spine stickleback	A, C	native, common	BPA et al. 1994b; Wydoski and Whitney 1979
Percopsis transmontana	sandroller	A, C	native, rare	Wydoski and Whitney 1979
Micrtopterus salmoides	largemouth bass	A, C	introduced, uncommon	Dell et al. 1975; Wydoski and Whitney 1979
Micrtopterus dolomieui	smallmouth bass	A, C	introduced, common	Wydoski and Whitney 1979
Pomoxis nigromaclatus	black crappie	A, C	introduced, common	Dell et al. 1975; BPA et al. 1994b
Pomoxis annularis	white crappie	A, C	introduced, common	Wydoski and Whitney 1979
Lepomis macrochirus	bluegill	A, C	introduced, uncommon	Dell et al. 1975; BPA et al. 1994b
Lepomis gibbosus	pumpkinseed	A, C	introduced, uncommon	Dell et al. 1975; BPA et al. 1994b
Stizostedion v. *vitreum*	walleye	A, C	introduced, common	Dell et al. 1975; Wydoski and Whitney 1979
Perca flavescens	yellow perch	A, C	introduced, common	Dell et al. 1975; Wydoski and Whitney 1979
Cottus confusus	shorthead sculpin	A, B, C	native, common	Wydoski and Whitney 1979
Cottus beldingi	Piute sculpin	A, B, C	native, common	Wydoski and Whitney 1979
Cottus rhotheus	torrent sculpin	A, B, C	native, common	Wydoski and Whitney 1979
Cottus cognatus	slimy sculpin	A, B, C	native, common	Wydoski and Whitney 1979
Cottus asper	prickly sculpin	A, B, C	native, rare	Wydoski and Whitney 1979
Cottus bairdi	mottled sculpin	A, B, C	native, common	Wydoski and Whitney 1979

A = Project Area B = Tributaries C = Columbia River System

Rainbow Trout

Rainbow trout is an inland (remains in freshwater) form of steelhead. However, some rainbow trout remain in freshwater for most of their life but undergo a physiological change to a smolt and migrate to the ocean late in life. In addition to the potential for rainbow trout to become anadromous, the progeny of steelhead are believed to have the potential to become resident rainbow (Peven 1990). Inland rainbow and juvenile steelhead are not distinguishable from each other until the steelhead undergo smoltification. The Mid-Columbia River tributaries contain a mixture of resident rainbow and ocean migrating steelhead. The ability of the species to alternate life-history strategies is an adaptive mechanism to variable environmental conditions.

Bull Trout

The Columbia River bull trout populations were also listed as threatened under the Endangered Species Act in June 1998 (USFWS 1998). Eight subpopulations have been identified in the Wenatchee, Entiat and Methow rivers, while they are thought to be extirpated from the Okanogan River. However, bull trout were likely never abundant in the mainstem Columbia River (Mongillo 1993). Factors identified in the decline of bull trout populations in the area include dams, forest management practices, livestock grazing, agricultural water diversions, roads and mining (Beschta et al. 1987). In addition, poaching and the presence of non-native fish species are adversely impacting bull trout populations (Mongillo 1993). Brook trout may have completely replaced bull trout in South Fork Beaver Creek, a tributary of the Methow River.

Four general forms of bull trout are recognized (anadromous, lacustrine, fluvial, and resident), each exhibiting a specific behavioral or life-history strategy (Brown 1992a; Pratt 1992). Anadromous bull trout are typically found in coastal and Puget Sound river drainages, yet are extinct in the Mid-Columbia River region (Nehlsen et al. 1991). The lacustrine (adfluvial) form matures in lakes or reservoirs and spawns in tributaries where the young reside for 1 to 3 years. Fluvial bull trout have a similar life history except that they move between the Columbia River mainstem and smaller tributaries.

The lacustrine and fluvial bull trout are of the most concern in the Mid-Columbia River tributaries (Brown 1992a), as their habitat has been degraded more than that for resident forms. The stream resident bull trout spend their entire lives in smaller, high elevation streams, apparently moving very little, and seldom reaching a size larger than about 12 inches (Brown 1994). Resident trout may have extensive seasonal movements or change life-history strategies (from resident to lacustrine) depending upon the current environmental conditions. This phenomenon may occur commonly for populations near Lake Wenatchee, where resident bull trout may migrate to the lake when stream flows (and attendant water temperatures) become intolerable. Habitat alterations that disrupt this capability to transmute may limit the population's stability.

Approximately 60 percent of the bull trout spawning and rearing habitat in the Methow River has been lost due to irrigation water withdrawals (USFWS 1998). Habitat degradation in the mainstem Entiat River from development and forest fires have severely depressed the densities of bull trout populations. Physical habitat problems are the most common detriment to bull trout populations, followed by flow and water quality problems. Bull trout are known for their need for cold pristine headwater areas during critical spawning and early life-history stages (Mongillo 1993). Thus, project operations do not affect spawning success, although the role of the projects on isolating populations and their genetic fitness is unknown. Bull trout are occasionally observed in the adult and juvenile fish passage facilities of the Mid-Columbia River dams, but little is known about their reservoir residency.

Pacific Lamprey

Pacific lamprey occur in most tributaries to the Columbia River and are believed to occur in the mainstem Columbia River during their migration stages. Little specific information is known, however, on the life history or status of lamprey in the Mid-Columbia River watersheds. Estimates of adult Pacific lamprey passing Rock Island Dam in 1996 and 1997 totaled 2,121 and 2,321, respectively (Jackson et al. 1996 and 1997). Passage estimates at Rocky Reach were 593 and 1,405 in those same years, while at Wells Dam the estimates were 979 and 773, respectively. Peak passage in those years occurred between August and September.

In general, the adults are parasitic on fish in the Pacific Ocean while the ammocoetes (larvae) are filter feeders that inhabit the fine silt deposits in backwaters and quiet eddies of streams (Wydoski and Whitney 1979). Adults generally spawn in low gradient stream reaches in the tail areas of pools and in riffles, over gravel substrate (Jackson et al. 1996). Adults die after spawning. Juveniles migrate from their parent streams to the ocean from March to July, peaking in April. It is not known how long Pacific lamprey live in freshwater prior to migration, but it is assumed to be 5 to 6 years (Wydoski and Whitney 1979).

Mountain Whitefish

Mountain whitefish are assumed to occur in all small order tributaries to the Wenatchee, Entiat, Methow, and Okanogan rivers, and in connecting larger lake systems. They are also believed to occur in the mainstem reservoirs, although their behavior patterns are not known. They mostly inhabit riffles in summer and large pools in winter (Wydoski and Whitney 1979). Spawning typically occurs from October through December; generally in riffles, but also on gravel shoals of lake shores. Mountain whitefish feed primarily on instar forms of benthic aquatic insects, although they also occasionally eat crayfish, freshwater shrimp, leeches, fish eggs, and small fish. In lakes, they feed extensively on zooplankton, particularly cladocerans. There is evidence that mountain whitefish historically spawned in lower reaches of some tributaries, but the mainstem hydroelectric dams inundated these habitats.

Pygmy Whitefish

Pygmy whitefish are found in relic populations in western North America, but the only known population in the project area is in Lake Chelan (Hallock and Mongillo 1998). This species inhabits lakes, typically staying deeper than 18 feet. They also resides in streams, preferring habitats with moderate to swift current. Little is known about the pygmy whitefish populations in the Mid-Columbia River region.

Northern Pikeminnow

Northern pikeminnow (formerly northern squawfish) are a slow-growing, long-lived predator. In summer, adult northern pikeminnow prefer shallow, low velocity areas in cool lakes or rivers. During the winter they use deeper water and pools (Scott and Crossman 1973). Spawning occurs during the summer, in shallow water areas with gravel substrate.

Northern pikeminnow are the most abundant predator species in the Columbia River system, and accounts for over 75 percent of the total catch of predator fish in the Mid-Columbia River (Loch et al. 1994). They tend to concentrate in tailrace areas downstream of mainstem dams during the juvenile salmonid migration period, holding in relatively slow-moving water areas (less than about 3 feet per second) near passage routes. They are also expected to occur in tributary streams where slow-moving water occurs.

Between 1994 and 1998, the predator abatement programs resulted in the removal of 24,552 northern pikeminnow at Rock Island Dam, 36,757 at Rocky Reach Dam, and 7,000 at Wells Dam (Chelan County PUD 1999b, Douglas County PUD 1999a).

Smallmouth Bass

Smallmouth bass (*Micropterus dolomieui*) are a non-native gamefish that have inhabited the Mid-Columbia River reach since at least the 1940s. Preferred habitat for this species includes rocky shoals, banks or gravel bars. Adult smallmouth bass in the Mid-Columbia River are most abundant around the deltas of warmer tributary rivers but do not occur in tributary streams. The optimal temperature range for this species is from 21° to 27° C (Wydoski and Whitney 1979), which is higher than the temperatures typically observed in the Mid-Columbia River reservoirs.

Ideal spawning temperatures for this species range from 15.5° to 18.5° C, although such temperatures do not occur consistently in the Mid-Columbia River reservoirs until late summer. Smallmouth bass build and defend nests in sloughs and littoral areas with sand and gravel substrates. Such areas are generally lacking in the Mid-Columbia River system. It is believed that primary natural reproduction of smallmouth bass in the Mid-Columbia River occurs only in the free-flowing Hanford reach below Priest Rapids Dam and in the Okanogan River.

Walleye

Walleye (*Stizostedion vitreum*) are a cool water, piscivorous gamefish believed to have moved downstream into the Mid-Columbia River reach from a population established for recreational fishing in Lake Roosevelt in the late 1950s (Zook 1983). They occur throughout the mainstem reservoirs but not typically found in the tributaries. Although suitable spawning habitat appears to be plentiful in the Mid-Columbia River, evidence of successful reproduction has not been observed (Zook 1983). Recruitment of walleye into the Mid-Columbia River reservoirs is suspected to result from the entrainment of young fish through Grand Coulee Dam during spring run-off (Zook 1983).

Other Resident Fishes

Little is known about the other mainstem Columbia River resident fish, and they are not expected to have substantial interactions with Plan species in the project area. These species include: yellow perch (*Perca flavescens*), largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*), bluegill (*L. microchirus*), brown bullhead (*Ictalurus nebulosus*), black bullhead (*I. melas*), channel catfish (*I. punctatus*), carp (*Cyprinus carpio*), goldfish (*Carassuius auratus*), chiselmouth (*Acrochelius alutaceus*), sandroller (*Percosis transmontanus*), and tench (*Tinca tinca*), various sucker species (*Catostomus* sp.), speckled dace (*Rhinichthys osculus*), longnose dace (*R. cataractae*), redside shiner (*Richardsonius balteatus*), peamouth chub (*Mylocheilus caurinus*), and sculpin (*Cottus* sp.) (Wydoski and Whitney 1979).

3.2.9 AQUATIC HABITAT

The mainstem hydroelectric projects throughout the Columbia River system have directly and indirectly resulted in substantial changes to the aquatic habitats. The most obvious direct effect was the change from a free-flowing river system to a series of reservoirs. This change resulted in the inundation of salmonid spawning and rearing habitat and the creation of habitat better suited to cool and warm water fish species. These reservoir impoundments not only change the aquatic habitat in the immediate vicinity of the dams, but also change the seasonal flow and water temperature variations throughout the basin.

3.2.9.1 Reservoir Habitat

Reservoirs have increased water depth, surface area, and retention time, and decreased water-mixing processes compared to free-flowing rivers. These factors combine to increase overall water temperatures, as well as to promote temperature stratification in the deep reservoir areas. As a result, reservoir releases are typically cooler in the spring and summer and warmer in the fall and winter, compared to natural conditions. However, these factors are largely influenced by the large storage reservoirs upstream of the Mid-Columbia River projects. The Mid-Columbia River projects are run-of-river facilities that have limited water storage or flow regulation capabilities (see Water Quality, Section 3.3.2).

The natural variation in seasonal flow is also highly modified in the Mid-Columbia River by the large upstream storage reservoirs associated with Chief Joseph, Grand Coulee, and other storage dams located in Canada that capture the spring run-off and release that water over an extended period. These yearly and seasonal changes to the natural aquatic environment have resulted in substantial changes to the aquatic ecosystem. The aquatic ecosystem consists of a sophisticated and delicate network of interrelationships between a wide range of biological organisms and habitats. Small changes in an ecosystem can have noticeable effects, although they might be isolated to a small number of organisms or habitat types.

One part of the aquatic ecosystem that is often particularly sensitive to changes in water quality is the benthic community. This community consists of a diverse assortment of plants and animals that grow or live on the bottom of lakes and rivers. Many of these organisms are sedentary or have limited mobility, so they are highly susceptible to environmental changes, such as fluctuations in water level or temperature. Benthic organisms are an essential part of the food chain on which resident and anadromous fish species depend. Other important food chain components include phytoplankton and zooplankton, which are tiny floating plants and animals.

Studies in the lower Columbia River have shown that juvenile chinook salmon (both ocean- and stream-type) actively feed during their outmigration. These fish feed on aquatic insects in the spring, switch to zooplankton during July and September and back to aquatic insects in the fall (Craddock et al. 1976). Stream-type chinook salmon in the Lower Granite reservoir were found to feed primarily on *chironomidae*, as well as minor amounts of *Cladocera*, *Ephemeroptera*, *Trichoptera*, *Plecoptera* and terrestrial insects (Chandler, J., Idaho Power Company, unpublished data). Due to limited reach-specific data, it is assumed that feeding habits of juvenile fish are consistent with those observed elsewhere in the system.

Juvenile Passage through Reservoirs

Reservoir impoundments can create increased rearing area and provide overwintering habitat for juvenile anadromous salmonids. It can also affect the outmigration of anadromous salmonid juveniles by causing extended travel times and decreased survival rates. The use of the term “extended travel times” refers to slower rates of travel by outmigrating juvenile anadromous salmonids. Juveniles, when exposed to extended travel times and increased water temperatures, can residualize (become residents) and fail to migrate to the ocean (NMFS et al. 1998b).

Raymond (1968, 1969, 1979) and Bently and Raymond (1976) estimated that juvenile anadromous salmonids move through the Snake River and lower Columbia River impoundments one-half to one-third slower than they would through free-flowing river sections of the same length. According to Raymond (1979) juvenile steelhead and chinook salmon migrate through free-flowing stretches of river at 14 miles per day, while they move through impounded waters at 5 miles per day. Fielder and Peven (1986) found similar rates (3 to 6 miles per day) for stream- and ocean-type chinook salmon and steelhead juveniles in the Mid-Columbia River reservoirs. Giorgi et al. (1997) reported the migration rates of PIT-tagged chinook salmon and steelhead smolts at 13.4 and 18.9 miles per day, respectively between Rock Island Dam and McNary Dam. This area includes the free-flowing Hanford Reach. By comparison, travel rates estimates for these same species (chinook salmon and steelhead) in the Snake River (with limited free-flowing reaches) were 4.6 and 8 miles per day (Rondorf and Banach 1996).

Increased migration times can affect the size and survival rate of juveniles, timing of ocean transition and thermal imprinting. Increased migration times can cause migrating juveniles, especially steelhead, to revert to parr (residualize). Laboratory evidence suggests that water temperatures in excess of 20° C for about 20 days, or delaying migration beyond the end of June, may cause steelhead smolts to revert to parr (Chapman et al. 1994b; Adams et al. 1975; Wagner 1974; Zaugg 1981). Some reverted parr residualize and are lost to anadromous production.

Extended travel times due to passage through reservoirs also increases potential exposure of juvenile outmigrants to predatory fish and reduces migration survival. Sims and Ossiander (1981) reported stream-type chinook salmon and steelhead juvenile survival improved with increasing flow. While increasing flow may increase migration speed and associated reservoir survival through the lower Columbia and Snake River impoundments, there is little evidence to suggest that increased flows will increase survival of spring-run chinook salmon in the Mid-Columbia River reach. However, there are some indications that survival of steelhead might be affected by flow (NMFS 1998; Chapman et al. 1994a).

Under existing conditions, water velocities in the Mid-Columbia River reach are typically greater than in the Snake and lower Columbia River system. The increased water velocities also result in faster juvenile migrations through the Mid-Columbia River reach. However, the faster travel in the Mid-Columbia River reach does not appear to improve overall survival, thus, it is uncertain if increasing the travel rate by increasing flows will substantially change survival rates in the Mid-Columbia River (NMFS 1998). In view of the uncertain benefit of increases in travel rates, improving juvenile outmigrant survival in the Mid-Columbia River reach may best be achieved by predator control and improved dam passage conditions.

Adult Passage through Reservoirs

There is little evidence to suggest that significant impacts on adult migration and pre-spawning mortality occurs in the Mid-Columbia River project reservoirs. Bjornn and Peery (1992) included information from Mid-Columbia River and other run-of-river reservoirs in their comprehensive review of the effects of reservoirs on adult salmon and steelhead. Based on the available information, they concluded that run-of-river reservoirs had minimal effect on migrating adults. Adult salmonids generally pass through these reservoirs at similar or faster rates than they do in the naturally flowing river. There is little evidence of disorientation, wandering, straying, or mortality associated with reservoir conditions.

Reservoir Habitat Use

Mainstem spawning and rearing habitat for anadromous salmonids in the Mid-Columbia River reach was inundated by the formation of five PUD reservoirs beginning at the Priest Rapids Dam and extending to the Chief Joseph Dam. The total surface area of the Columbia River between Priest Rapids and Chief Joseph dams doubled from 23,000 to 46,000 acres following inundation by the dams (Mullan et al. 1986). Since upstream passage facilities were not provided when Chief Joseph Dam was constructed, Chief Joseph Dam is the upstream extent of mainstem anadromous salmonid production. Natural anadromous salmonid spawning in the mainstem Mid-Columbia River presently is limited primarily to the free-flowing Hanford reach downstream of Priest Rapids Dam, and to the major tributaries including the Wenatchee, Chelan, Entiat, Methow and Okanogan River systems. Some limited mainstem spawning also occurs in the upstream portions of the reservoirs in project tailrace areas where streambed hydraulics and substrate conditions allow (Carlson and Dell 1989, 1990, 1991, 1992; Dauble et al. 1994; Chapman et al. 1994a).

Whitefish, trout, and char were the dominant resident species prior to reservoir inundation. The change from a free-flowing environment undoubtedly eliminated much of the spawning and rearing habitat of these resident salmonid fish populations. Under present conditions, few salmonids reside in the reservoir and their numbers probably represent less than 1 percent of the total fish numbers (Dell et al. 1975; Zook 1983; Mullan et al. 1986). Habitat alteration created a subsequent shift in species composition toward dominance by cool water non-game species. Non-game fish such as sucker, chub, pikeminnow, and shiners, comprise the majority of the reservoir resident fish population (Columbia River System Operation Review Draft EIS 1994; BPA et al. 1994b).

Reservoir production concerns and issues are related to a reduction in fish habitat for spawning and juvenile rearing life-history stages. The factors affecting reservoir habitat for these life stages are discussed in the following sections.

Spawning Habitat

Existing mitigation for losses of mainstream spawning habitat due to inundation by the reservoirs is set forth in the existing FERC licenses for the projects. Additional concerns related to reservoir effects on the existing spawning sites include: deposition of fine sediments that may reduce incubation and spawning success; scour and relocation of gravel near the tailrace of each dam; and pool level fluctuations and the possibility of reduced production through redd dewatering.

Sediment Deposition and Gravel Scouring

Smoothing of the hydrograph and lack of significant flow velocities as a result of Columbia basin hydroelectric development has increased the amount of fine sediment present in mainstem cobble substrate, especially in the lower portions of reservoirs (Falter et al. 1991). However, mainstem anadromous salmonid spawning is concentrated in dam tailrace areas, where conditions are most like a free-flowing river. River hydraulics in these areas are sufficient to maintain well-sorted substrates, relatively free of fine sediment, and velocities that meet spawning preferences of salmonids.

Columbia River mainstem tributaries have the potential to deposit bedload material into reservoirs, forming alluvial fans at the confluences. If the accumulation of fine sediment is not excessive, then bedload material could provide a good source of spawning substrate, as long as local water velocities are appropriate for spawning and they are sufficient to keep excessive levels of fine sediment from accumulating throughout the incubation stage. Fine sediment loading in the Okanogan basin is considered high, while the Methow and Wenatchee river systems transport a moderate level of fine sediment (Rensel 1993).

To date, mainstem spawning in the tailrace areas has probably been increasing since the 1980s (Mullan 1987; Chelan County PUD 1991), although this apparent increase may be an artifact of researchers spending more time and effort looking for mainstem spawning. Such data indirectly suggest any gravel relocation in the tailraces has not adversely reduced spawning opportunities. Thus, tailrace hydraulic effects may be maintaining spawning opportunities in the reservoirs, particularly for summer- and fall-run chinook salmon (Chapman et al. 1994a).

Fluctuation of Pool Elevations

Maximum pool fluctuations in Mid-Columbia River reservoirs are generally less than 10 feet, although they occur primarily in winter (Zook 1983; Chapman et al. 1994a) during the period when chinook salmon embryos and alevins are incubating in the substrate. Water level fluctuations can have an adverse effect on embryos depending upon the degree and duration of the fluctuation and embryo development stage. Studies indicate prolonged periods of dewatering, up to 12 days, do not reduce embryo survival (Becker et al. 1983; Neitzel et al. 1983). After hatching, alevins can withstand only brief periods (1 to 2 hours) of dewatering without reductions in survival.

Reservoir spawning is suspected to occur in relatively deep mainstem waters near the upstream portions of the reservoirs. Giorgi (1992) observed chinook salmon spawning in the Wells Dam tailrace area (Rocky Reach reservoir) at depths between 8 and 23 feet, with most redds constructed at depths greater than 20 feet. Thus, fluctuations up to 10 feet should not affect spawning and incubation success for deep reservoir spawning, although production occurring in less than 10 feet of water may be subject to the effects of fluctuating water levels.

Spawning Locations

The importance of mainstem Columbia River reservoir spawning habitats varies by species and race/deme. There is no evidence of substantial mainstem spawning for spring-run chinook salmon, steelhead, sockeye or bull trout in the Mid-Columbia River reservoirs. The following species-specific accounts focus on mainstem spawning conditions in the Mid-Columbia River basin.

Ocean-Type Chinook Salmon

Summer/fall-run chinook salmon are known to spawn in the upstream portions of reservoirs, or tailrace areas, where stream velocities, substrate and inter-gravel flows are sufficient to support redd development and embryo incubation (Chapman et al. 1994a). However, the most significant fall-run chinook salmon spawning area in the Mid-Columbia River occurs downstream of Priest Rapids Dam in the free-flowing Hanford reach (Carlson and Dell 1989; Chapman et al. 1994a). Currently, naturally spawning ocean-type summer-run chinook salmon are also found in the Wenatchee, Okanogan, and Methow rivers (Waknitz et al. 1995). Summer-run chinook salmon are also reported to spawn in the lower Entiat and Chelan Rivers, in addition to below mainstem Columbia River dams (Marshall et al. 1995); however, it has not been determined whether or not these are self-staining populations.

Stream-Type Chinook Salmon

Stream-type (spring) chinook salmon spawning has not been observed in the reservoir areas, except at the mouths of tributary streams that are inundated by reservoir water. However, some potential spawning could occur in areas of substantial groundwater upwelling.

Sockeye Salmon

Sockeye salmon spawning in the Okanogan and Wenatchee rivers has been documented during September to October (Mullan 1986). Limited spawning may occur in the Methow and Entiat rivers maintaining remnant sockeye salmon populations from previous introductions (Mullan 1986). Because of the necessity for juvenile lake rearing, sockeye salmon are not regarded as a mainstem spawner.

Steelhead

Summer steelhead spawning has not been observed in the reservoirs but some potential spawning could occur in areas of substantial groundwater upwelling. Past decisions regarding mitigation for steelhead spawning habitat have assumed that steelhead used the reservoirs (Chelan County PUD 1991). As a result, the effects of reservoir inundation on steelhead spawning production may be expected to be similar to that for summer/fall-run chinook salmon.

3.2.9.2 Project Area Rearing

Factors with the potential to affect the rearing capacity of reservoirs include habitat condition, flushing rate, aquatic productivity, level of submerged macrophyte growth, and water quality conditions. The potential effects of these factors on rearing habitat are discussed below.

Habitat Conditions

The Mid-Columbia River hydroelectric projects are operated as run-of-the-river facilities with reservoirs that have relatively rapid flushing rates and limited thermal stratification during summer. Most shorelines are steep with relatively little littoral area in comparison to their size. Rapid water exchange and relatively featureless shorelines limit juvenile anadromous salmonid rearing habitat. The majority of reservoir margins are undeveloped, and riparian habitat adjacent to the reservoir is sparse, characteristic of the dry land climate.

Reservoir Flushing and Turnover Rate

Water retention, or flushing rate, of reservoirs is a function of the total reservoir volume divided by inflow over a given period of time. The mean annual flushing rate of Mid-Columbia River reservoirs ranges between 0.6 and 5.6 days. Such rapid flushing rates are primarily related to the shallow depths of the reservoirs. Average water velocity through the Mid-Columbia River reach is estimated to be 0.9 to 3.1 feet per second at river flows between 79,000 to 270,000 cfs (Chapman et al. 1994b). Reservoir flushing rate is an important consideration for aquatic productivity as discussed below.

Aquatic Productivity

Aquatic productivity is typically high in free-flowing sections of mainstem rivers. Dauble et al. (1980) found a diverse aquatic macroinvertebrate and zooplankton community in the Hanford reach below Priest Rapids Dam. Reservoir inundation typically decreases productivity and diversity of benthic and limnetic organisms (Mullan 1986). The invertebrate community is dominated by chironomids, oligochaetes and zooplankton (Falter et al. 1991). Thus, juvenile salmonids (which prefer large, high energy content food items [such as trichoptera]) switch first to chironomids, then to zooplankton as abundance of the preferred food items decline (Rondorf and Gray 1987). Therefore, productivity may limit the feeding efficiency of juvenile anadromous salmonids, who must expend more energy to capture lower energy content prey in the reservoirs as compared to free-flowing reaches.

Most of the primary and secondary production potential in the Mid-Columbia River region is generated from upstream sources. Lake Roosevelt (upstream of Grand Coulee Dam) is the single most important factor influencing aquatic productivity in the downstream PUD reservoirs due to the slow turnover rate, large storage capacity and source of nutrients (Rensel 1993). The thermal regime of the Mid-Columbia River is also influenced by releases from Grand Coulee Dam. Lake Roosevelt exhibits strong thermal stratification during summer months. Since Grand Coulee Dam is not equipped with selective depth-withdrawal facilities, downstream water temperatures are heavily dependent on the depth of the Lake Roosevelt thermocline.

The flow-through characteristics of the Mid-Columbia River Dam reservoirs result in primary productivity being largely dependent on detritus, sessile (attached) algae, and macrophytes (Mullan 1986). The turnover time of water in the pool is too short in summer to permit development of extensive and diverse zooplankton communities.

Submerged Macrophytes

Submergent aquatic plants are increasing in some of the Mid-Columbia River reservoirs. The benthic community in these submerged macrophyte beds is similarly increasing as riverine macrophytes effectively create substrate by velocity reduction and subsequent particle trapping, encouraging settling of organic-rich soils (Falter et al. 1991). Macrophyte beds eventually increase the production of benthic food organisms, as well as providing additional surface area for algae and invertebrates. They may also provide cover for rearing juvenile anadromous salmonids and other fish species.

The dominant species within the aquatic plant communities in the Mid-Columbia PUD reservoirs (Truscott 1991) is non-native Eurasian water milfoil (*Myriophyllum spicatum*), which forms large, dense monotypic beds with a relatively low volume to edge ratio. These conditions may not provide as much cover and rearing opportunities as native plants, but they still offer substantial shallow water rearing habitat. Only under very dense conditions, would milfoil act to reduce the productive capacity of aquatic habitats.

Given the steep bathymetry of the reservoirs, it is not likely that the density of submerged macrophytes would become a problem for fish rearing. Therefore it is reasonable to conclude that continued development of macrophyte beds in the reservoirs should improve aquatic productivity in the reservoir and benefit shallow water fish rearing.

Fish Stranding Potential

Many small fish, including chinook salmon fry, use shallow water habitat and embayments along the reservoir shoreline. Trenches or depressions in the river bottom can form isolated pools at low reservoir levels. Juvenile fish trapped in such pools can perish from desiccation, if the pool drains as water moves through the substrate, or from increased predation. However, Mid-Columbia River reservoirs generally consist of steep morphologies along the river margins and have very little backwater or shallow areas (Zook 1983) thereby reducing the potential for stranding juvenile fish.

Coordination within the Mid-Columbia River hydroelectric system strives to hold all reservoirs as close to full as possible to optimize gross head (Mid-Columbia Hourly Coordination Agreement). Flow reductions following evening peaking may create rapid decreases immediately downstream of the projects. However, Mid-Columbia River reservoirs typically encroach on the tailraces of upstream dams, which moderates elevation fluctuations in the tailrace and reduces the potential to strand juvenile fish.

Water Quality

Water quality in the Mid-Columbia River reach is influenced by the operation of Grand Coulee Dam; the Mid-Columbia PUD projects have limited capability for flow regulation. Dissolved oxygen is adequate in all reaches, with exception of some extreme backwaters where aquatic weed growth restricts water flow. Turbidity is generally very low in the reservoirs (Rensel 1993). However, spilling water at the projects increases the total dissolved gas levels that can cause gas bubble disease in fish and other aquatic organisms. Additional information regarding water quality in the Mid-Columbia River reach is found in Section 3.3.2.

<u>Project Area Rearing</u>

The importance of mainstem Columbia River reservoir habitat for rearing juvenile anadromous salmonids varies by species and race/deme. Stream-type (spring) chinook salmon, steelhead and sockeye salmon do not appear to use the shoreline habitats of the mainstem Columbia River, but outmigrate in the mid-channel areas of reservoirs (Burley and Poe 1994; Dauble et al. 1998). The river is regarded as a migration corridor in which food may be encountered. Limnetic zooplankton and drift may be a primary food source of yearling outmigrants (Burley and Poe 1994).

Spring-Run Chinook Salmon

Spring-run chinook salmon utilize the mainstem Columbia River primarily as a migration corridor. As a result, they spend little time rearing in the Mid-Columbia River reservoirs (Chapman et al. 1995a).

Ocean-type (Summer/Fall-Run) Chinook Salmon

Ocean-type (summer/fall) chinook salmon juveniles use the mainstem reservoirs for rearing in late spring and early summer (Chapman et al. 1994a; Burley and Poe 1994). Recently emerged ocean-type chinook salmon juveniles rear throughout the shallow, low velocity areas of the reservoirs in April and May. After reaching approximately 2 inches in size, they move slightly offshore into faster flowing water (Chapman et al. 1994a). Chinook salmon might feed on limnetic species when available, but prefer benthic macroinvertebrates in the drift when rearing (Chapman et al. 1994a). Based on these criteria, it appears that most suitable chinook salmon rearing habitat is found in the upstream portions of the reservoirs, where river velocities are greater and the substrates are coarser (less fine sediment) than downstream in the reservoirs. However, no surveys have been done in the Mid-Columbia River reservoirs to verify habitat preferences and rearing areas of ocean-type chinook salmon.

Summer-Run Steelhead

Ninety percent of the steelhead production upstream of the Priest Rapids project occurs in hatcheries (Chapman et al. 1994b). The balance of the production occurs in the tributaries, although some minor amount of reservoir rearing may occur during overwintering periods. Although steelhead feed in the reservoirs during their seaward migration, the reservoirs serve primarily as migration corridors rather than as rearing habitat (Chapman et al. 1994b).

Sockeye Salmon

Although sockeye salmon could conceivably rear in the reservoirs, the rapid flushing rate, low primary productivity and lack of abundant zooplankton limit production potential. The Wells pool may be a source of rearing habitat for the small but sustained run of Methow River sockeye salmon (Bickford 1994; Chapman et al. 1995b), and the Rocky Reach pool for the remnant run of Entiat River sockeye salmon (Mullan 1986; Chapman et al. 1995b).

Predation

Construction of hydropower facilities on the Mid-Columbia River has created impoundments with habitat more conducive to predators compared to the pre-impounded free flowing river. Changes in physical habitat, water quality and downstream passage conditions have combined to increase the risk of juvenile outmigrant mortality due to predation (Mullan et al. 1986; Chapman et al. 1994b). Dams present an obstacle to the downstream migration of juvenile anadromous salmonids, often causing them to concentrate in forebays before finding a route past the dam.

Concentrations of juvenile anadromous salmonids provide a ready food supply for predators that congregate at such sites (Beamesderfer and Rieman 1991). Passage through turbines, spillways or bypass facilities may stun, disorient or injure some juvenile anadromous salmonids, making them less capable of escaping predators. Sediment that formerly would have been suspended during high spring flows settles out in upstream impoundments, resulting in reduced turbidity in the Mid-Columbia River. Clearer water makes juvenile outmigrants potentially more visible and more susceptible to predation.

In addition to juvenile outmigrants being more susceptible to predators while migrating past the dams, the number of predators is presumed to have increased to levels greater than pre-impoundment conditions in the Mid-Columbia River reach. The deep, low velocity habitat created by impoundments is preferred by northern pikeminnow, the major native predator fish of juvenile anadromous salmonids. Two other gamefish species, walleye and smallmouth bass, were introduced into the Columbia River system in the 1940s to 1950s to provide sport-fishing opportunities (Zook 1983). These piscivorous gamefish have become established in the Mid-Columbia River reservoirs, and they also prey on juvenile anadromous salmonid outmigrants. The following sections provide a general background description of predation in the Mid-Columbia River reach, and they identify potential methods for reducing predation on juvenile anadromous salmonids.

In the Columbia River basin, a predator indexing approach is used to estimate the magnitude of predation on juvenile salmonids by piscivorous fish (Vigg and Burley 1990). Modeling results indicate that piscivorous fish consume up to 19 percent of all juvenile salmonids migrating through the John Day reservoir, and up to 61 percent of ocean-type chinook salmon (Riemen et al. 1991). Because of their abundance and high consumption indices, northern pikeminnow are the most significant predator, accounting for approximately 78 percent of juvenile salmonids lost to predation. Introduced predator species, such as smallmouth bass and walleye, accounted for the remainder of the losses.

Northern Pikeminnow

The northern pikeminnow is a slow-growing, long-lived predator. In summer, adult northern pikeminnow prefer shallow, low velocity areas in cool lakes or rivers. During the winter they use deeper water and pools (Scott and Crossman 1973). Northern pikeminnow pose the greatest predation threat to migrating juvenile anadromous salmonids in the Columbia River system because of their number and distribution. Northern pikeminnow accounted for over 75 percent of the total catch of predator fish in the Mid-Columbia River (Loch et al. 1994).

Juvenile salmonids are not a major prey species for northern pikeminnow in riverine environments under natural conditions because they prefer slack water habitat that is limited in the unimpounded areas of the Mid-Columbia River region (Brown and Moyle 1981). A study in the free-flowing portion of the Willamette River found that only 2 percent of the northern pikeminnow stomachs sampled contained juvenile salmonids, despite the fact that sampling took place during the peak juvenile salmonid outmigration (Buchanan et al. 1981).

Because of the concentrations of prey and favorable hydraulic conditions, areas adjacent to and downstream of tailraces have become preferred feeding habitat of northern pikeminnow. The gut contents of northern pikeminnow collected from the tailrace sampling areas at all of the Mid-Columbia River projects contain a higher proportion of juvenile salmonids than pikeminnow collected in the forebays or mid-reservoirs of the same projects (Sauter et al. 1994). In a study conducted in the John Day reservoir from 1983 to 1986, juvenile salmonids accounted for 21 percent of the diet of northern pikeminnow less than 12 inches in length and 83 percent of the diet of larger pikeminnow (Poe et al. 1991). The length of juvenile salmonids consumed by northern pikeminnow also increases progressively with the length of the pikeminnow.

Smallmouth Bass

Smallmouth bass are a gamefish that have inhabited the Mid-Columbia River reach since at least the 1940s. Preferred habitat for this species includes rocky shoals, banks, or gravel bars. Adult smallmouth bass in the Mid-Columbia River are most abundant around the deltas of warmer tributary rivers.

In a 1993 survey of the Mid-Columbia River system conducted by the National Biological Survey and the WDFW, smallmouth bass were the second most abundant predator species captured, but accounted for only 9 percent of the total catch (Sauter et al. 1994). The majority of the bass were taken from the reservoir forebays, and the fewest from the tailraces (Burley and Poe 1994). The overall abundance of smallmouth bass in the Mid-Columbia River system appears to be low.

The preference of smallmouth bass for low velocity shoreline areas in the Mid-Columbia River reservoirs may reduce their predation on some juvenile salmonid outmigrants. While juvenile stream-type salmonid outmigrants move through the mid-reservoir areas and may avoid substantial interactions with smallmouth bass, juvenile ocean-type salmonid migrants use the shoreline areas and may be an important prey item for smallmouth bass (Poe et al. 1991).

Walleye

Walleye are a cool water, piscivorous gamefish believed to have moved downstream into the Mid-Columbia River reach from a population established for recreational fishing in Lake Roosevelt in the late 1950s (Zook 1983). Although suitable spawning habitat appears to be plentiful in the Mid-Columbia River, evidence of successful reproduction has not been observed (Zook 1983). Recruitment of walleye into the Mid-Columbia River reservoirs is suspected to result from the entrainment of young fish through Grand Coulee Dam during spring run-off (Zook 1983).

Walleye were the least abundant predator encountered in the 1993 National Biological Survey investigation in the Mid-Columbia River, accounting for only 4 percent of all predators caught (Burley and Poe 1994). Of the walleye captured during this survey, 89 percent were caught from dam tailraces, while the remaining 11 percent were caught in mid-reservoir and forebays (Loch et al. 1994). The relatively high numbers of walleye caught in dam tailraces during the spring suggest that walleye may be attracted to the concentrations of juvenile salmonids there. However, investigations of walleye food habits on the lower Columbia suggest that walleye in the tailraces are not responding to concentrations of juvenile salmonids. Juvenile salmonids accounted consistently for only 18 to 24 percent of the walleye's diet (Sauter et al. 1994), even when large concentrations of juvenile salmonids were available.

Because of the generally low level of juvenile salmonid consumption and relative scarcity of walleye in the Mid-Columbia River reservoirs, they are not considered to have a major impact on juvenile salmonid survival migration at this time.

Gulls

Juvenile anadromous salmonids near tailraces of the Mid-Columbia River projects are also susceptible to predation by birds. Ring-billed gulls are the most prevalent avian predator in the Mid-Columbia River reach. This is a ubiquitous species with very general habitat preferences. Gulls forage below dams where turbulent currents from the spillways and turbines carry young juvenile salmonids near the surface. Ruggerone (1986) estimated that ring-billed gulls consumed 2 percent of the salmon and steelhead passing Wanapum Dam in 1982. Since that time, wires strung across dam tailraces have hindered bird access to vulnerable juvenile salmonids and, coupled with gull hazing programs, are believed to substantially reduce predation losses.

3.2.9.3 Tributary Spawning and Rearing Habitat

There are four major tributaries in the project area: Wenatchee, Entiat, Methow, and Okanogan rivers. By the turn of the century, logging, irrigation, and mining activities combined to severely impact the tributary habitats throughout the Columbia River basin, including the Mid-Columbia River region. However, current conditions have improved because of the removal of small dams on some tributaries, screening of irrigation diversions, increased protection of riparian corridors from logging practices, and reduced mining activities. In addition, some habitat restoration or protection activities (such as improving fish passage conditions at culvert crossings, establishing minimum instream flow criteria, and restricting live stock access to stream bank and riparian areas) have improved the tributary habitat. Despite these improvements, tributary habitat quality and quantity is still a limiting factor in the recovery of anadromous fish stocks in the Mid-Columbia River region.

As a result of the long history of impacts to salmonid populations and their habitats in the Mid-Columbia River region, it is reasonable to assume a substantial reduction in the life-history diversity among these stocks. Decreased diversity is due, in part, to the simplification of the available habitat through riparian and stream-channel modifications, reduced instream flows, and the existence of fish migration barriers. Large-scale introductions of hatchery fish have also contributed to the reduction of life-history diversity within the stocks. Species that adopt several life-history patterns can maximize the use of diverse habitats, occupy vacant niches, and are more robust to periodic dramatic environmental upheavals in a watershed. As a greater percentage of the fish populations become reliant on a single habitat, the impacts resulting from a disturbance or elimination of that habitat also increase.

Habitat needs of anadromous salmonids in the Mid-Columbia River tributaries vary by season and life stage. Upstream adult migration, spawning, incubation of the eggs, juvenile rearing, and seaward migration of smolts are the major life stages for most anadromous salmonids.

Adult salmonids returning to their natal streams must arrive at the proper time and in good health if spawning is to be successful. Unfavorable flow, temperature, turbidity, or water quality conditions could delay or prevent fish from completing their migration. Man-made barriers (such as impassible drops, improperly installed culverts, diversion dams, impoundments, and excessive velocities) may also impede migrating fish.

Hiding and resting cover habitat, clean substrate of appropriate size and composition, and water quality and quantity are important habitat requirements for anadromous salmonids before and during spawning. Cover for fish can be provided by overhanging vegetation, undercut banks, submerged vegetation, woody debris, water depth, and turbulence.

Some anadromous fish–chinook salmon and steelhead, for example–enter the tributaries months before they spawn, so cover is essential for them during this holding period. The suitability of a particular size gravel substrate for spawning depends mostly on fish size, but all require gravel substrate, relatively free of silt.

The timing of hatching and fry emergence of salmon and steelhead varies among the different stocks and spawning areas. These differences are primarily due to variations in temperature during the incubation period. After hatching, alevins (yolk-sac larvae) remain in the gravel for an extended period of time. As their yolk-sacs are absorbed, alevins emerge from the gravel and disperse into a wide variety of habitats. Flow, water velocity, and depth determine the amount of suitable rearing habitat. Other important features of suitable rearing habitat are substrate composition and cover habitat.

The highest production of invertebrates occurs in shallow water habitats with gravel and cobble substrate, and decreases with larger or smaller substrate material (NMFS et al. 1998b). The amount, type, and location of cover is important during the juvenile rearing phase because it provides food, shade (for temperature stability), and protection from predators.

Wenatchee Watershed

Wenatchee River has about 163 miles of stream accessible to anadromous salmonids. The Federal government is the largest landowner in the watershed. Private ownership is limited to less than 25 percent of the total watershed area, but encompasses nearly two thirds of the lineal area of the anadromous streams (NMFS et al. 1998b). Most of these lands are irrigated orchard areas located in the lower watershed. Although the large diversions are equipped with modern fish screens, many unauthorized smaller intakes may be operating without screens (NMFS et al. 1998b).

Fish Resources

The Wenatchee River supports several populations of economically and culturally important fish species. The watershed currently supports anadromous runs of chinook salmon, sockeye salmon, and steelhead. Native coho salmon were once present in the Wenatchee watershed (Mullan et al. 1992), but are now extinct (Nehlsen et al. 1991). Other abundant resident species include mountain whitefish, kokanee (landlocked sockeye salmon), bull trout, rainbow trout (a resident form of steelhead), and westslope cutthroat trout. A discussion of the three major evolutionary life-history strategies (ocean-type, stream-type, and resident) exhibited by these fish populations are provided below.

Spring-Run Chinook Salmon

Spring-run chinook salmon return to the Wenatchee River from late April through June. Spawning begins in early August in the upstream reaches of the tributaries, and continues downstream through September. Juveniles emerge from the gravel from late March through early May, generally spend their first summer in the subbasin, and leave in late fall through the following spring. The peak of spring migration is late April through May. The average estimated natural escapement to the Wenatchee River (based upon redd count expansions) is 2,929 fish for the period 1960 to 1969, 2,354 for the period 1970 to 1979, 1,838 for the period 1980 to 1989, and 509 for the period 1990 to 1995.

The primary spawning areas are the Chiwawa River between Grouse and Phelps creeks, Nason Creek between Kahler and Whitepine creeks, the Little Wenatchee River between river mile 0.6 and 7, the White River between Sears Creek and White River Falls, and the mainstem Wenatchee River between Chiwaukum Creek and Lake Wenatchee (Peven and Truscott 1995). Spawning is observed annually in Icicle Creek as well, but it is likely that most of these fish are of hatchery origin (Washington Department of Fish [WDF] et al. 1993). A limited amount of spawning has also been reported in Peshastin, Chumstick, and Mission creeks (USFS 1994b).

Summer/Fall-Run Chinook Salmon

Summer/fall-run chinook salmon return to the Wenatchee River primarily in July and August. They spawn in the mainstem between the outlet of Lake Wenatchee downstream to the confluence with the Columbia River (about 54 miles). Juveniles generally emigrate to the ocean as subyearling fry, leaving the Wenatchee River from 1 to 4 months after emerging from the gravel in April. However, it is likely that some cohorts also rear in the mainstem, Lake Wenatchee, or tributaries through winter when conditions are favorable to this strategy. Summer/fall salmonids are most dependent on habitat in the mainstem Wenatchee River downstream of Plain. From 1960-1994, the average escapement of ocean-type chinook salmon was 8,826 fish (based on differences in adult and jack counts at Rock Island and Rocky Reach dams), with a range from 3,394 to 13,625 fish.

Sockeye Salmon

Columbia River sockeye salmon adults generally begin entering the river in April and May. Peak passage at Bonneville Dam typically occurs around the third week in June, and about 1 month later at Rock Island (Chapman et al. 1995b). However, the Wenatchee sockeye salmon population migrates upstream earlier than the Okanogan stock. The principle spawning areas for Wenatchee River sockeye salmon are river mile 0 to 5 on the Little Wenatchee River, from river mile 6 to 10 on the White River, and the lower reaches of Nepeequa River (WDF et al. 1993). In addition, some fish may spawn along the shoreline at the upper end of Lake Wenatchee. As such, sockeye salmon are vulnerable to bulkhead construction because of mechanical damage to redds, altered gravel composition, and reduced nutrient input.

Unauthorized filling and disruption of springs and groundwater seeps, and removal of riparian vegetation also would affect these spawners and decrease fry production. Spawning occurs from mid-September to mid-October. Juveniles move downstream from the rivers to Lake Wenatchee immediately after they emerge from the gravel (March through May). Most of the juveniles (about 82 percent) reside in Lake Wenatchee for 1 year prior to emigration, while some reside 2 years in the lake. A small percentage of sockeye salmon remain in Lake Wenatchee their entire life as kokanee.

Steelhead

In general, adult steelhead migrate into the Mid-Columbia River tributaries in both fall and early spring. Spawning occurs primarily in late March, but may extend longer in some years. Steelhead use the mainstem Wenatchee River and eight of its tributaries: lower Mission, Sand, Brender, Peshastin, Chumstick, Icicle, Chiwaukum, and Nason creeks, and the Chiwawa, Little Wenatchee, and White rivers. Fry emerge in late spring to August and they disperse downstream in late summer and fall. Some fry and parr rear in the mainstem Wenatchee all year. They exhibit a wide range of life-history characteristics, including highly variable, freshwater residence periods, and a broader range of spawning areas (extending higher in the tributaries than stream-type chinook salmon).

Those individuals using upper reaches of tributary habitats (Peshastin and Mission creeks), have probably been more heavily impacted by forest practices, improper grazing practices, stream channel alterations, and unauthorized water withdrawals than have stream-type chinook salmon. Again, riparian and shoreline impacts are a major problem. Smolts typically leave the Wenatchee River in March to early June, after residing 1 to 7 years in freshwater. Although most leave after 2 or 3 years, some remain in freshwater their entire lives (Peven et al. 1994).

Resident Salmonids

Resident rainbow trout, bull trout, and westslope cutthroat trout use the Wenatchee River and tributary habitat for most or all their life. Although little is known about their specific population dynamics or demographics, they are presumed to exhibit a wide range of life-history patterns.

Bull Trout

The principal spawning areas for bull trout in the Wenatchee River are in Panther Creek (tributary to

White River), and the Chiwawa River and other selected tributaries (Rock, Chikamin, Phelps, Alpine, James, and Buck creeks) (Brown 1992b). Other lesser populations are known to occur in Nason, Chiwaukum, Eightmile and French, and Ingalls creeks. Bull trout occur throughout the mainstem Wenatchee River from the Columbia River to Lake Wenatchee, although their numbers appear to be low in most areas upstream of Tumwater. The lacustrine form principally spawns in the White River drainage, whereas those bull trout that spawn in the Chiwawa drainage exhibit more of a fluvial life-history strategy (Brown 1992b).

Fishing pressure is a major factor in the decline of bull trout in the Wenatchee watershed (Brown 1992b). In 1992, however, harvest of bull trout was prohibited in the Columbia River and most tributaries of Washington State, including the Wenatchee watershed. With the exception of high levels of sediment in some spawning areas, the new USFS prescriptions for managing stream corridors and riparian habitat are considered adequate for protection of bull trout on public lands (Brown 1992b). However, the consequences of past activities continue to affect bull trout and their habitat (USFWS 1998).

Westslope Cutthroat Trout

Several genetically "pure" and "essentially pure" cutthroat populations occur in the Wenatchee watershed. These populations include: Chiwawa River (Phelps, Rock, Buck creeks, and the mainstem headwaters), Little Wenatchee River (Rainy, Lake, and Snowy creeks, and the mainstem headwaters), White River (Napeequa River and mainstem headwaters), Nason Creek (Smith Brook and Gill Creek, and the mainstem headwaters), Icicle Creek (Jack and French creeks, and mainstem headwaters), and Negro Creek in the Peshastin drainage. Other creeks may have genetically pure or essentially pure stocks, but these populations have not been sampled.

Habitat Conditions

Forest practices can result in multiple habitat impacts, including reduced riparian canopy, increased fine sediment loads, reduced pool habitat, lost off-channel habitats, and increased run-off. Prior to 1988, timber harvests in the watershed left no stream-side buffers along the channels. However, subsequent harvests have incorporated minimum riparian buffers on fish-bearing streams that do not necessarily provide adequate shade or large woody debris recruitment.

Water quality is generally good in the Wenatchee River but water temperatures are above those preferred by salmonids in July, August, and September, particularly during low flow years. The agrarian and historical logging land use practices have increased summer water temperatures above what they would be under natural conditions, and conversely, have probably decreased winter temperatures.

Although fish habitat protection is of primary concern to fishery managers, they have only limited jurisdiction over land and water uses that impact habitat. The Peshastin Creek channel is largely defined by Highway 97. Chumstick and Mission creeks have been straightened and realigned along much of the historical anadromous zone. While the portion of Icicle Creek still accessible to anadromous fish remains highly sinuous, its banks have been rip-rapped along much of this reach, and its historical maze of side channels and oxbows have been filled in, or cut off from the main channel.

Riparian and Stream Channel Condition

Flood control dikes, gravel mining, and channel straightening associated with rail lines and roads have dramatically simplified habitat in the lower mainstem Wenatchee River. Wood removal, and the loss of wood recruitment resulting from these and other actions have exacerbated conditions. Today, the lower mainstem is almost entirely devoid of large woody debris, and there is virtually no remaining riparian vegetation. These practices, in combination, constitute the greatest impact to salmonid habitat in the mainstem Wenatchee downstream of Leavenworth.

In general, the lower mainstem river channel would be described as a moderately entrenched, moderate gradient, riffle dominated channel with infrequently spaced pools and stable banks. The upper mainstem Wenatchee River (from Chiwaukum confluence upstream) is a low gradient, meandering, point bar, riffle/pool, alluvial channel with broad, well defined floodplains.

The upper Wenatchee River between the Lake Wenatchee and Leavenworth is impacted less than the reach downstream of Leavenworth. Some rip-rap and general bank protection projects exist in the Plain area along with riparian clearing near some homes along the river. Downstream from Leavenworth, orchards and homes now occupy much of the river's riparian area.

White River

The lower White River is the principal spawning area for sockeye salmon and adfluvial bull trout. It has an average slope of 1 percent and has shallow entrenchment within a wide, flat-floored, glacial valley. The stream is about 65 feet wide (wetted width), with a relatively even distribution of pool, glide, and riffle habitat. Stream canopy cover is also relatively good.

Nason Creek

Nason Creek flows through a sedimentary glacial canyon, and is relatively unconfined. There are some areas of excessive scour from both natural events and human alterations, and other areas are altered by rip-rap placement. Some side channels and oxbows have been cut off from the main channel by construction of U.S. Highway 2.

Chiwawa River

The Chiwawa River is the largest tributary to the Wenatchee River. Private homes and property are adjacent to Chiwawa River for the first 5 miles, near the confluence of Chikamin Creek and in several other tributary sections. In general, the habitat is riffle dominated, with pools associated with log jams and meanders, although the river has limited large woody debris or pools per unit stream length. No known fish passage barriers occur in the stream. There are numerous roads throughout the watershed. A water diversion is located at river mile 4.4, and has a capacity of diverting 30 cfs that may reduce downstream rearing habitat in late summer. A satellite to the Rock Island Fish Hatchery Complex is located at river mile 0.6.

Icicle Creek

Lower Icicle Creek is an unconfined alluvial stream, with a relatively low gradient. An unquantified, but substantial amount of stream bank has been altered by riparian vegetation removal or rip-rap placement. The barrier dam at Leavenworth National Fish Hatchery blocks access to more than 19 miles of historical habitat. Viable populations of rainbow trout, bull trout, cutthroat trout, and brook trout occur upstream of this barrier.

Chumstick Creek

Chumstick Creek is a substantial source of sediment to the Wenatchee River due to riparian habitat degradation along the creek. Although there is some potential for steelhead and stream-type chinook salmon production, this system appears primarily suited for coho salmon. A large culvert under the North Peshastin Road (near the mouth of Chumstick Creek) is a passage barrier for adult salmonids, and several smaller upstream culverts are suspected to hinder upstream passage of salmonids at certain times. Summer flows, at least in drier years, appear to be low enough to prevent adult salmonid staging and spawning. Juvenile salmonids have been observed in lower Chumstick Creek, closely associated with the patchy riparian cover.

Peshastin Creek

Stream-type chinook salmon still use this system. Historically, steelhead and coho salmon probably spawned in this system. Irrigation diversions are suspected of blocking adult migrations; no chinook salmon have spawned in Peshastin Creek in some years. The impacts of water diversions on juvenile rearing is not known.

Riparian vegetation along the mainstem, where it has not been totally cleared, is primarily deciduous trees and shrubs. As a result, the mainstem channel receives a very limited supply of the large woody debris. Currently, in-channel conditions appear to limit stream-type chinook salmon overwintering above the U.S. Highway 2 crossing. Below the crossing, the gradient flattens considerably, but the lack of riparian vegetation also makes for poor rearing and overwintering habitat. The stream channel in Peshastin Creek has been altered and straightened by construction of U.S. Highway 97 from the mouth to Scotty Creek. As a result, water velocities (and resultant bedload) are very high, making this stream virtually unusable by salmonids at all life stages.

Mission Creek

Mission Creek is a substantial source of sediment to the Wenatchee River. Adult stream-type chinook salmon cannot get above the irrigation diversions (steelhead can in wet years), and the spawning conditions in the lower creek are generally unsuitable. High sediment loads, peak flows, and pre-spawning water temperatures, along with limited adult resting habitat, are all problems for stream-type chinook salmon in this watershed. Juvenile chinook salmon and rainbow/steelhead overwinter in lower Mission and Brender creeks, however.

Lake Wenatchee

Lake Wenatchee is the only nursery lake for sockeye salmon in the Wenatchee watershed. It is a typical oligotrophic lake, being relatively clear with low productivity. Mullan (1986) classified Lake Wenatchee as classic sockeye salmon rearing habitat: cold, clear well-oxygenated, but infertile water. The White and Little Wenatchee rivers deliver most of the inflow, as the basin is relatively small, and the Wenatchee River is the outflow.

Lake Wenatchee is highly susceptible to housing development. The amount of shoreline development that has occurred along the lake has increased in recent years. Many bank hardening and dock construction permits have also been issued. Such activities disrupt sediment dynamics and decrease the productivity of littoral zones. The construction of bulkheads, removal of riparian vegetation, and shoreline clearing on Lake Wenatchee is a departure from natural conditions. This practice reduces wood and nutrient recruitment to the lake and downstream habitats.

The Relationship of Existing Aquatic Habitat Conditions to Biological Productivity

Ocean-Type Chinook Salmon

These fish encounter habitat that has been heavily impacted by development in the valley bottomlands. It is believed that summer-run chinook salmon spawning in the lower Wenatchee River (downstream of Mission Creek confluence) do not enter the river until shortly before they spawn. Thus, they avoid warm water conditions and usually encounter higher flows than earlier spawners. Flows during the second half of October are on average 25 percent higher than those in the latter half of September. However, in drier years, later migrating fish may have difficulty accessing the area upstream of Leavenworth. Sedimentation, gravel scour and anchor ice are potential sources of pre-emergence mortality.

The early rearing environment for chinook salmon is relatively poor. The combination of natural and artificial channel confinement severely limits the availability of suitable early rearing habitat. Velocity refugia are primarily associated with rip-rap and afford little cover from predators. Habitat limitations include velocity refugia and cover. Late rearing habitat quality is also limited by a lack of in-channel diversity. The lack of cover, particularly as flows drop in the summer and fall, may be limiting the success of this group of fish.

Overwinter habitat quality was also severely reduced by the actions described above. Winter water temperatures often hover near freezing, so ice can occupy most of the substrate in this reach in a cold winter with low flows.

Stream-Type Salmonids

Based on stream survey information (from USFS, WDFW, and Chelan County PUD) and the observations of fish biologists familiar with the basin, most Wenatchee River stream-type anadromous fish spawn higher in the watershed than ocean-type fish, in habitats least modified by land use practices. Early rearing also occurs in more pristine areas (Hillman and Miller 1994). A portion of the juvenile population may move downstream gradually during summer and fall for over-winter rearing. Here they encounter increasingly altered conditions where recruitment of shelter habitat (primarily large woody debris) and food supply is reduced because of the loss of forested riparian areas. Conditions in the upper Chiwawa and White rivers are considered particularly good, whereas, Nason Creek has been straightened and contains limited large woody debris in most of the anadromous zone. Similarly, the mainstem Wenatchee River in and around Plain and the lower Chiwawa River have lost considerable large woody debris and in-channel diversity as a result of shoreline development.

Forest practice impacts to stream-type salmonids are expected to improve if the riparian buffers required by the USFS remain in effect, and if forest road construction techniques and maintenance standards continue to improve. The Little Wenatchee River and Nason Creek each experience very low flows during the late summer, but it is not known whether this phenomenon results from forest management. The current forest hydrology models that have been applied to these watersheds indicate only slight exacerbation of peak and summer low flows. No data regarding spawning gravel condition are available. The upper mainstem Wenatchee River still shows the scouring effects of historical in-channel log drives.

Shoreline development is the greatest in-basin habitat problem and probably the greatest threat to this salmonid life-history type, especially in the lower river rearing and overwintering zones. The areas most threatened by additional development are the White River below the Nepeequa River, the Chiwawa River below Deep Creek, most of the anadromous portion of Nason Creek, and the Wenatchee River mainstem between Lake Wenatchee and Tumwater Canyon.

Stream-type anadromous salmonids that spawn or rear in the middle and lower sections of main tributaries encounter conditions different than those that existed before development. Water withdrawals are significant problems in all of the lower river tributaries. Portions of Peshastin and Mission creeks may be completely dewatered, during the late summer, by irrigation withdrawals. Icicle and Chumstick creeks may also be diverted.

Sockeye salmon spawning habitat is limited to the lower gradient riffles within the accessible portions of the White, Little Wenatchee and Nepeequa rivers. Suitable spawning areas exist primarily where the rivers and their floodplains are unconfined. About half of the spawning habitat in the White River is bordered by private property. Development reduces the riparian vegetation, and stream banks begin to erode. If this situation continues on the White River, sockeye salmon production will likely decline.

Large woody material and higher flows provide cover to protect fish from poaching, harassment, and predation for mature stream-type anadromous salmonids in the summer and fall. Importance of shelter habitat increases as forest road construction provides easier fishing access and vulnerability to legal and illegal harvest.

Resident Fish

Many of the key habitat factors that apply to anadromous salmonids also apply to resident fish. Resident salmonids are found with anadromous fish in many areas but usually reside in smaller order streams with higher gradients. They occur primarily in more forested drainages away from many of the habitat problems associated with bottomland development (bank protection, channelization, water withdrawal). Key habitat conditions for resident fish (in particular, rainbow trout, westslope cutthroat trout, and bull trout) revolve around minimizing sedimentation and gravel scouring and providing the necessary cool water temperatures and adequate cover.

Entiat Watershed

The Entiat watershed is the smallest of the four considered in this assessment, and probably also the simplest ecosystem. About 90 percent of the watershed is publicly owned. Less than 25,000 acres is privately owned, although more than 75 percent of the riparian habitat for anadromous salmonids in the mainstem Entiat River is privately owned. Most of the upper drainage is considered a Federal key watershed for bull trout, salmon, and steelhead (USFS et al. 1994a). The Entiat basin suffered four major burns within the last 25 years – the Entiat Fire in 1970 (burned 22 percent of the watershed), the Crum Canyon Fire in 1976 (4 percent), the Dinkleman Fire in 1988 (20 percent), and the Tyee Fire in 1994 (36 percent).

Fish Resources

The Entiat River supports several populations of economically and culturally important fish species. The watershed currently supports anadromous runs of chinook salmon and steelhead. Coho salmon were once present in the Entiat watershed (Mullan et al. 1992), but are now considered extinct (Nehlsen et al. 1991). Passage barriers on the Entiat River at the turn of the century probably contributed to their extinction. Important inland species include mountain whitefish, bull trout, westslope cutthroat trout, and rainbow trout. A recreational fishery exists for steelhead, resident rainbow, and brook trout. No sport fishing for bull trout, salmon or steelhead is allowed on the Entiat River. The spring and summer-run chinook salmon and steelhead populations were listed as depressed (WDF et al. 1993).

In general, spawning and rearing habitat for salmon and steelhead are considered to be in very good condition in the upper reach of the Entiat River (from Potato Creek confluence to Entiat Falls) and poor in the lower Entiat (USFS 1996).

Spring-Run Chinook Salmon

Stream-type (spring) chinook salmon return to Entiat River from late May through July. The primary spawning areas are the mainstem river upstream of the terminal moraine (river mile 16) to Fox Creek confluence (river mile 28). Spawning begins in early August in the upstream reaches, and continues downstream through August and September. The average escapement estimate, based on dam counts (turnoff estimates), has decreased from about 3,229 redds for the period 1960 to 1969, to about 1,056 redds for the period 1990 to 1995. However, some of these escapement values are not corroborated by redd count expansions, done recently by USFWS.

Juveniles emerge from the gravel from late March through early May, generally spend their first summer in the subbasin, and leave in late fall through the following spring. The peak of the spring migration is late April through May, but downstream movement from the tributaries may be continuous, and not always associated with parr/smolt transformation.

Summer/Fall-Run Chinook Salmon

It is suspected that ocean-type summer/fall-run chinook salmon were not a dominant life-history strategy in the Entiat River system (Craig and Suomela 1941). Ocean-type chinook salmon return to the Entiat River primarily in July and August, but may enter the river into early October. They spawn in the mainstem Entiat River from the Preston Creek confluence downstream to its confluence with the Columbia River (23 miles). Spawning begins in late September in upstream reaches, peaks mid-October, and ends in early November in the lower river (Peven 1992). Juveniles probably emigrate to the ocean as subyearlings, leaving the Entiat River from 1 to 4 months after emerging from the gravel in April.

Based upon redd counts, the ocean-type chinook salmon escapement to the watershed averaged 37 for the period 1957 to 1966, 55 redds for the period 1967 to 1976, 9 redds for the period 1977 to 1986, and 11 redds for the period 1987 to 1991. In 1995, 40 ocean-type chinook salmon redds were observed in the mainstem Entiat River downstream of river mile 20. No summer-run chinook salmon spawn in the tributaries of Entiat River. Juveniles may rear from a few months to a year before migrating downstream. Two general life-history types are presumed for ocean-type anadromous fish in the basin: (1) spawn in the mainstem and leave the system in late spring/summer as subyearlings, and (2) spawn in the mainstem and leave the system in fall as subyearlings. However, some cohorts rear in the Entiat River through winter when conditions are favorable to this strategy.

Sockeye Salmon

Sockeye salmon are not indigenous to the Entiat River (Craig and Suomela 1941). After they were propagated at Entiat National Fish Hatchery between 1941 and 1969, small numbers of sockeye salmon adults are occasionally observed in the Entiat River during spawning ground surveys for chinook salmon (Carie 1996). These fish are either strays from the Wenatchee and Okanogan stocks, or they may be artifacts of the Entiat National Fish Hatchery releases (Mullan 1986). Little is known about the life history of Entiat sockeye salmon; they are assumed to rear primarily in the impounded lower reach of the Entiat River and the mainstem Columbia River (Chapman et al. 1995b). Spawning occurs from mid-September to mid-October. It is assumed that juveniles move downstream from the Entiat River to the Columbia River reservoir immediately after they emerge from the gravel (March through May).

Steelhead

Steelhead spawn in the upper Entiat River and some tributaries from mid-March through late May. Most steelhead spend 1 to 2 years rearing in the mainstem or its tributaries, although an almost continuous outmigration from the river occurs during this period. Movements are complex and not fully explainable. After nearly 14 months of rearing in a hatchery (Chelan, Wells and Eastbank fish hatcheries), smolts are planted into the mainstem Entiat River from mid-April through mid-May. Almost 10 percent of these hatchery fish are believed to spend an additional year in residence prior to emigration. Most steelhead smolts leave the system at age 2 or 3, depending upon stream temperatures, and spend 2 years at sea.

Natural steelhead stock/recruitment relationships from several reports show little or no replacement. For at least the last twenty years, natural spawning populations in the system are predominantly of hatchery origin. Steelhead exhibit a wide variety of life-history strategies. Again, riparian and shoreline impacts are a major in-basin problem for steelhead.

Resident Salmonids

Resident rainbow trout, bull trout, and westslope cutthroat trout use the Entiat River and tributary habitat most or all their life. Although little is known about their specific population dynamics or demographics, they are presumed to exhibit a wide range of life-history patterns.

Many of the key habitat factors that apply to anadromous salmonids also apply to resident fish. Resident salmonids are found with anadromous fish in many areas but usually reside in smaller order streams with higher gradients. They occur primarily in more forested drainages away from many of the habitat problems associated with bottomland development (bank protection, channelization, water withdrawal). Key habitat conditions for resident fish (in particular rainbow trout, westslope cutthroat trout, and bull trout) revolve around minimizing sedimentation and gravel scouring, and providing cover.

Habitat Conditions

Forest practices impacts are minor in the Roaring Creek drainage, but they are significant in some smaller tributaries (Burns, Preston, Brenegan, McCree creeks). Forest roads in the Potato, Mud, and Crum watersheds are typically located in the narrow floodplains of the mainstems and their tributaries. This road location practice can result in multiple habitat impacts including reduced riparian canopy, increased fine sediment loads, reduced pool habitat, and lost off-channel habitats. Such roads also directly reduce watershed storage capacity by rapidly routing run-off into stream channels and by compacting floodplain soils, and also indirectly by discouraging beaver pond construction. Recently, there have been extensive road obliteration and reconstruction projects in the Wenatchee National Forest–primarily for riparian restoration. Timber harvests have left buffers on fish-bearing streams, but the minimum requirements do not always result in adequate shade or large woody debris recruitment.

Upland erosion is a chronic problem in the Entiat watershed, yet substantial restoration efforts are underway in the Wenatchee National Forest to address this problem. Several streambank stabilization projects are proposed for the erosive banks on the mainstem Entiat River. Using properly applied bioengineering methods, these projects can provide instream habitat for adult and juvenile salmonids.

However, such remedies are not an adequate substitute for natural stream channel/floodplain conditions. Road closures and obliteration, extensive reforestation, culvert upgrades and other efforts are currently proposed for the forest, and will help to improve fish habitat. There are highly erosive areas along Fox, McCree, Brenegan, Preston, and Mud creeks, Crum Canyon, and the mainstem Entiat between Fox and Stormy creeks. Relative to hazards from forest land erosion and fluvial sedimentation, streambank erosion is not a significant problem on the Entiat River-mostly because the riparian vegetation in the upper reach is adequate for avoiding erosion, and the Army Corps of Engineers has provided extensive channeling and rip-rap armoring in the lower reach.

To protect stream-type chinook salmon, WDFW recently imposed selective resident fishery regulations throughout much of the anadromous fish zone that should significantly reduce juvenile hooking mortality. Portions of the zone however, remain open to bait fishing. The recently abandoned practice of planting catchable hatchery rainbow trout in this portion of the sub-basin probably had some impact on chinook salmon smolt production. Large woody material and higher flows provide cover habitat to protect mature stream-type anadromous salmonids from poaching, harassment, and predation. Importance of cover habitat increases as forest road construction provides easier fishing access and vulnerability to legal and illegal harvest.

Water temperatures are not a serious problem in the lower Entiat River; maximum temperatures are typically less than 15° C, which is tolerable for rearing juveniles. In winter, anchor ice is a problem in the Entiat below Ardenvoir and in the Mad River. Sediment levels, especially fine sediments, are impacting beneficial uses, primarily aquatic habitat and irrigation. These sediments are derived from both natural and human-caused (accelerated) sources.

Riparian and Stream Channel Condition

Based upon the 1995 stream channel inventory and work presented in Mullan et al. (1992), habitat diversity in lower Entiat River is remarkably low (riffle:run:pool ratio is 0.72:0.25:0.03). In contrast, the upper reach has 28 percent pools, which the USFS rates as good. The distribution of large woody debris is similar, with a low incidence in the lower river and appreciably better in the upper reaches. These two factors (lack of pools and woody debris), are the primary limitations to natural production of salmon and steelhead on lower Entiat River. Much of this can be attributed to the flood-control projects undertaken by the Army Corps of Engineers under the 1946 Federal Flood Control Act.

Most habitat upstream of Entiat Falls is rated as fair to excellent, with fewer than 25 percent of the surveyed reaches in the upper river not meeting the USFS standard for pool habitat (USFS 1996). The habitat quality between McCrea Creek and Entiat Falls is rated as fair to excellent, and habitat quality downstream of McCrea Creek is rated as fair to poor (USFS 1996). Spawning and rearing habitat in Mad River is poor to fair up to Young Creek, which is well beyond the reach of anadromous salmonids.

The Entiat valley was impacted by major flood events in the 1940s and 1970s. As a result, virtually all of the lower 22 miles of the Entiat River has been channeled–a dike on one side, and the Entiat River road on the other. Stream sinuosity is low, with very few point bars for gravel accumulation. The lower 12.5 miles of the mainstem Entiat River is highly channeled, resulting in a trapezoidal stream channel for the bankfull width. Instream habitat diversity is very low, with few pools, glides, or pocket water. As a result, there are very few resting areas for both adult and juvenile salmon.

The lower mainstem is almost entirely devoid of large woody debris, and there are some areas with no remaining riparian vegetation. These conditions constitute the greatest impact to salmonid habitat in the mainstem Entiat downstream of Mad River. Sedimentation, gravel scour and anchor ice are potential sources of pre-emergence mortality. The early rearing environment is fairly hostile; the combination of natural and artificial channel confinement severely limits the availability of suitable early rearing habitat.

Velocity refugia are primarily associated with rip-rap and afford little cover from predators. Late rearing habitat quality also lacks in-channel diversity. The lack of cover, particularly as flows drop in the summer and fall, may also be limiting the salmonid productivity. Overwinter habitat is also limited in the lower river due to ice often occupying most of the substrate in a cold winter following a dry summer.

Methow River Watershed

Methow watershed has five subwatersheds, and a total drainage area of 1,146,800 acres. Of the four watersheds in the Mid-Columbia River region, the Methow watershed has the most land in public ownership (94 percent), yet it ranks low in annual flows (about 1,600 cfs, measured at Pateros). Methow watershed has an average run-off (cfs) per square mile of drainage area of 1.1 cfs, compared to 1.9 cfs and 2.6 cfs for the Entiat and Wenatchee watersheds, respectively (Mullan et al. 1992). Most of the riparian bottomlands in the reach accessible to anadromous salmonids are privately owned. Very little of the watershed is irrigated agriculture. Only 12,800 acres of the private land in the basin are irrigated cropland (orchard, pasture, and hay); the majority of the watershed is National Forest land.

Fish Resources

The Methow River supports several populations of economically and culturally important fish species. The watershed currently supports anadromous runs of chinook salmon and steelhead. Sockeye salmon are occasionally observed (Chapman et al. 1995b). Important inland species include mountain whitefish, bull trout, rainbow trout, and westslope cutthroat trout. A recreational fishery exists for steelhead, resident rainbow, cutthroat, and brook trout. Currently, no sport fishing for salmon is allowed on the Methow River. Bull trout continue to be legally harvested from the Lost River, a tributary to the upper Methow River. Wild spring and summer-run chinook salmon and steelhead populations were listed as depressed (WDF et al. 1993). Fish passage into the Methow River was significantly impeded from 1912 until the 1930s by a hydroelectric dam built across the river at Pateros.

Spring-Run Chinook Salmon

Stream-type spring-run chinook salmon return to Methow River from late May through July. The primary spawning areas are the mainstem Methow River upstream of the Chewuch River confluence, the Twisp, Chewuch, and Lost rivers, as well as Thirtymile and Lake creeks. Spawning is observed occasionally in Foghorn Ditch as well, but it is likely that the fish spawning here are of hatchery origin (WDF et al. 1993). A very limited amount of spawning has also been reported in Early Winters, Wolf, and Gold creeks (USFS 1994a).

Spawning begins in early August in the upstream reaches of the tributaries, and continues downstream through August and September. The average estimated natural escapement to Methow River (which includes wild and hatchery fish, and is based upon redd count expansions) is 3,429 for the period

1960 to 1969, 2,471 for the period 1970 to 1979, 1,061 for the period 1980 to 1989, and 772 for the period 1990 to 1995. The escapement to Methow River (as measured at Wells Dam) in 1995 was 72.

Juveniles emerge from the gravel from late March through early May, generally spend their first summer in the subbasin, and leave in late fall through the following spring. The peak of the spring migration begins around the end of April and continues through May, but downstream movement from the tributaries may be continuous, and not always associated with parr/smolt transformation.

Summer/Fall-Run Chinook Salmon

Ocean-type summer/fall-run chinook salmon return to the Methow River primarily in July and August, but may enter the river into early October. No summer-run chinook salmon spawn in the tributaries of the Methow, and virtually all summer-run chinook salmon spawn downstream of the Chewuch River confluence. The furthest downstream spawning is near the mouth of French Creek, a total of 38 miles of spawning habitat. That section consists of four valley bottom types. Spawning begins in late September in the upstream reaches and ends in early November in the lower river. Emergence timing is probably January through April. Juveniles may rear from a few months to a year before migrating downstream. Juveniles generally emigrate to the ocean as subyearling fry, leaving the Methow River from 1 to 4 months after emerging from the gravel in April.

Ocean-type salmonids are most dependent on habitat in the mainstem Methow River. From 1967 to 1991, the average redd deposition of ocean-type chinook salmon to the Methow River was 464 redds (based on adjusted aerial survey estimates), with a range from 93 to 1,055 redds.

Sockeye Salmon

Sockeye salmon adults are observed nearly every year in Methow River during spawning ground surveys for chinook salmon. The 1990 to 1994 average number of sockeye salmon observed in the Methow River was 53 (range: 13 to 90) (Chapman et al. 1995b). These fish are either strays from the Wenatchee and Okanogan stocks, or they may be artifacts of the Winthrop National Fish Hatchery releases between 1945 and 1958 (Mullan 1986). Genetically and demographically, these salmon appear to be more similar to the Wenatchee stock than the Okanogan stock (Chapman et al. 1995b).

Little is known about the life history of Methow sockeye salmon; they are assumed to rear primarily in the impounded lower reach of the Methow River and the Columbia River mainstem (Chapman et al. 1995b). Although not generally referred to as such, sockeye salmon are “stream-type” in that they reside in freshwater (nursery lake) for more than a year. Spawning occurs from mid-September to mid-October. It is assumed that juveniles move downstream from the river to the reservoir immediately after they emerge from the gravel (March through May).

Steelhead

Steelhead use the mainstem Methow River and eleven of its tributaries: Black Canyon, Gold, Libby, Benson, Beaver, Early Winters, and Wolf creeks; and the West Fork Methow, Chewuch, Twisp, and Lost rivers (NMFS et al 1998b). In general, steelhead adults migrate into the Methow River in both fall and spring after spending 1 to 3 years in the ocean (Wydoski and Whitney 1979). Spawning occurs primarily in late March, but may extend into July. Their eggs incubate from late March through June, and fry emerge in late spring to August.

Steelhead exhibit a wide range of life-history strategies throughout the basin. Fry and smolts disperse downstream in late summer and fall. Some fry and parr rear in the mainstem Methow River all year. Their use of tributaries for rearing is variable, depending upon population size, and both weather and flow conditions. Most smolts leave the Methow River in March to early June, after spending 1 to 7 years in freshwater, but most leave after 2 to 3 years (Peven et al. 1994). However, some steelhead residualize and spend their entire lives in freshwater. Wild/natural steelhead exhibit an almost continuous outmigration from the river throughout the year.

After nearly 14 months of rearing in a hatchery (primarily Wells fish hatchery, but recently also at Winthrop National Fish Hatchery), the smolts are planted into the mainstem Methow River from 20 April until 20 May. Almost 10 percent of these hatchery fish stay an additional year in freshwater prior to emigration. Most steelhead smolts leave the system at age 2 or 3, depending upon stream temperatures, and spend 2 years at sea. Currently, and for at least the last 20 years, steelhead spawning in the watershed are predominantly hatchery descendants.

The average hatchery steelhead run-size from 1983 to 1992 was 15,015 fish with an average sport catch of 7,804 fish and tribal catch of 388 fish, Thus leaving 6,623 fish to escape to spawn in the Methow watershed. Natural steelhead comprise about 10 percent of the total steelhead run in the Methow River system. Depending upon assumptions of hatchery fish viability, the stock recruitment relationships for Methow River wild steelhead are either at replacement or markedly below replacement (NMFS 2000e).

Resident Fish

Resident rainbow trout, bull trout, and westslope cutthroat trout use Methow River and tributary habitat most or all their life. Although little is known about their specific population dynamics or demographics, they are presumed to exhibit a wide range of life-history patterns in the basin.

The status of rainbow trout in the Methow River is not known. It is assumed that the Methow system contains a mixture of full time resident rainbow and ocean migrating steelhead. Mullan et al. (1992) detected rainbow trout/steelhead in the mainstem Methow from the mouth to river mile 76.5, and in selected reaches of the following tributaries: Gold, Lake, Wolf, Early Winters, Foggy Dew, Crater, Beaver, Bridge, War, Eightmile, Twentymile, Goat and Trout creeks; the Twisp, Chewuch, and Lost rivers.

Bull trout have been sampled or observed in selected reaches of: Buttermilk, Goat, Wolf, Early Winters, Lake, Reynolds, South, and Monument creeks; Lost and Twisp rivers, and the West Fork and mainstem Methow River (Mullan et al. 1992). Brook trout have been widely stocked into the Chewuch and Twisp rivers since the 1920s. These fish are prolific in some tributaries to these rivers and pose a substantial risk to bull trout because these two species hybridize, and produce sterile offspring (Platts et al. 1993).

Habitat Conditions

Water withdrawal is a major factor in the overall management of the Methow watershed, but is practiced on only 1 percent of the drainage. Of the four Mid-Columbia River tributaries, the effect of irrigation on instream flows is most acute in the Methow (Chapman et al. 1995a). Instream flows limit salmonid production at virtually all stages of the freshwater life cycle. Mullan et al. (1992) assert that a strong hydraulic continuity exists between the Methow River and the groundwater aquifer from river mile 27.5 to 50, and that dewatering of the stream channel between river mile 62 and 74 may be a natural event that is independent of irrigation diversion. They suggest that some irrigation water diverted in summer may return to the river in winter low flow periods through groundwater recharge.

In some areas, forest roads increase fine sediment loading, reduce pool habitat, and reduce access to off-channel habitats. Such roads also directly reduce watershed storage capacity by rapidly routing run-off into stream channels and by compacting floodplain soils, and also indirectly by discouraging beaver pond construction. Timber harvests have left buffers on fish-bearing streams, but the minimum requirements have not always resulted in adequate shade or large woody debris recruitment.

To protect stream-type chinook salmon, WDFW recently imposed selective resident fishery regulations throughout much of the anadromous fish zone that should significantly reduce incidental juvenile hooking mortality. Portions of the zone however, remain open to bait fishing. The recently abandoned practice of planting catchable hatchery rainbow trout in selected areas has probably reduced incidental harvest of chinook salmon smolts.

Riparian and Stream Channel Condition

Many channel sections of the Methow River are constrained by rip-rap or channel incision, so that low velocity areas for deposition of fines are limited. Although the effects of surface erosion on salmonid production is not a major concern in the Methow, various actions are currently being considered to mitigate those impacts that do occur. In the Twisp watershed, for example, road obliteration projects are proposed by the Okanogan National Forest for about twenty roads and more spur roads. Similar actions are proposed for the Chewuch watershed.

Boulder Creek watershed, the largest drainage in the Chewuch system, has had several mass wasting events in recent history. Significant bank erosion presently occurs in the lower 25 miles of the Chewuch River. Channel downcutting is evident in many parts of this reach, lowering the water table and disconnecting the channel from its floodplain and riparian area.

The peak flow typically occurs from late April to early June and is caused by low elevation snow melt. Low flows occur from September and October, but often the winter flows are lower than that of summer. Up to 90 percent of the water withdrawn from instream flow is used for agricultural irrigation. A total of about 248 cfs is diverted from the Methow River and its tributaries for irrigation, although these values vary considerably, depending upon total stream flow, time of year, and other factors.

Eggs, yearling salmon and steelhead, and all age classes of trout and char are impacted in low flow years. Ironically, these areas are often where the highest densities of spring-run chinook salmon redds and rearing juveniles are found (Hubble and Sexauer 1994). This dewatering appears to be a natural phenomenon, exacerbated by water use for irrigation. The reaches that go dry during low flow years in the Methow watershed expand in length during extreme drought years. In 1992, WDOE completed an instream flow study that identified the following areas as most prone to dewatering:

- between Weeman Bridge and Mazama Bridge, about 1.6 miles;
- between the Early Winters Creek confluence and the Lost River confluence, about 5.5 miles;
- from the Lost River confluence to the Robinson Creek confluence, about 0.9 mile; and
- Libby and Gold creeks.

The WDOE has established instream flow requirements for the Methow watershed (Chapters 173-548 Washington Administrative Code [WAC]). These flows are used to condition new water rights, but do not affect water rights acquired prior to adoption of the instream flow rules.

Mainstem Methow River. In the subbasin plan, the Washington Department of Wildlife et al. (1989) state that the upper reaches of the Methow River have a riparian zone that is fairly wide and undisturbed. It has isolated damage from natural events, limited agricultural developments, grazing, logging, and road construction. The middle and lower reaches appear to have some damage from livestock grazing and agricultural development. However, the quality of substrate in the mainstem Methow is in relatively good condition (Chapman et al. 1994a). Gradient, discharge, and substrate combine to keep accumulations of sediment from occurring in the mainstem (Chapman et al. 1994a). From the confluence of the Chewuch River downstream, the Methow River is in a moderately confined alluvial valley with an average gradient of 0.4 percent.

Chewuch River. While there are some areas in the Chewuch River where habitat is in poor condition, a large portion of the drainage is in very good condition. Stream width-to-depth ratios are relatively high in some reaches. Roughly half the drainage, covering the portions of the watershed north and east of Lake Creek, is relatively undisturbed and functionally intact. However, some areas are deficient in large woody material, mostly due to stream cleanouts for flood control, salvage of instream wood, and extensive stream-channel harvest of potential recruitment trees. Portions of the lower Chewuch River have been channelized as a result of bank protection efforts after the 1948 flood.

Twisp River. Large woody debris is limited in some sections of the Twisp River, thereby reducing salmonid production. Pool-to-riffle ratios in the Twisp River also indicate a lack of instream cover.

The Relationship of Existing Habitat Conditions to Biological Productivity

Ocean-type Salmonids

It is unclear why the summer-run chinook salmon population in the Methow River is not as robust as those in the Wenatchee and Okanogan rivers. In general, the condition of spawning gravels in the lower Methow is good, as is water quality during the majority of their residence. Mullan et al. (1992) maintain that, historically, the Methow River had smaller runs of chinook salmon than other Mid-Columbia River tributaries. There is evidence that some subyearlings remain in the Methow River throughout the summer, and emigrate in fall (Chapman et al. 1994a). If a large component of the population remains through summer, they may be impacted somewhat by irrigation water withdrawals. These withdrawals may also reduce adult migration, holding, and spawning habitat (Chapman et al. 1994a), and effectively increase summer water temperatures.

Stream-type Salmonids

The mainstem Methow River and tributaries can be a limiting environment for salmonids during the late summer, low flows and in winter. Stream channel confinement provides adequate depth and cover for salmonids, yet temperature and flow extremes during both summer and winter may cause significant mortality. Based upon analyses of aerial photographs, Chapman et al. (1995a) observed that 6.4 percent of the mainstem Methow River from the Chewuch River confluence downstream to the mouth has extensive placements of rip-rap and 4.1 percent has no riparian vegetation. This lack of riparian coverage would allow significant loss of thermal insulation to the river.

Much of the spawning and early rearing habitat for spring-run chinook salmon lies upstream from irrigation diversions and return flows and is in a permeable glacial deposit. Although not directly influenced by irrigation, some reaches of the upper Methow and Twisp rivers are alternately watered and dewatered. Irrigation is known to dewater portions of Gold, Benson, and Beaver creeks. Flow is much reduced by irrigation in the lower Twisp River and in Wolf, Goat, and Early Winters creeks (Chapman et al. 1995a). The effects of irrigation water diversions would be especially severe in drought years. Pre-spawning mortality may also be a significant factor for spring-run chinook salmon in the Methow (Chapman et al. 1995a). Among a myriad of potential causes could be the lack of appropriate cover habitat associated with large woody debris.

Loss of woody debris in the lower Chewuch and Twisp rivers may exacerbate the movement of juvenile chinook salmon out of those tributaries in the fall, and into areas that may be less suitable for overwinter holding. Chapman et al. (1995a) believe that fry habitat in the Methow River may be limited, because the river has large segments with unvegetated banks (both eroded and laid-back banks) that would not provide suitable habitat for fry at high flows. Juvenile stream-type salmonids have been documented in lower reaches of smaller tributaries that often go dry in late summer (examples are: Gold, Libby, Beaver, and Wolf creeks).

Resident Fish

Many of the key habitat factors that apply to anadromous salmonids in the Methow watershed also apply to resident fish. Resident salmonids are found with anadromous fish in many areas but usually reside in smaller order streams with higher gradients. They occur primarily in more forested drainages away from many of the habitat problems associated with bottomland development (bank protection, channelization, water withdrawal). Key habitat conditions for resident fish (in particular rainbow trout, westslope cutthroat trout, and bull trout) revolve around minimizing sedimentation and gravel scouring.

Okanogan Watershed

The Okanogan River originates in British Columbia and flows through several large lake systems before reaching the United States. Most of the following discussion is on that portion within the United States. Migration barriers are an important issue in Okanogan watershed. The Okanogan/Similkameen watershed is the biggest and most complex ecosystem of the four Mid-Columbia River tributaries, and has the largest portion in private ownership. Land use is about equally dominated by forest and rangelands. Despite the extensive private lands, the largest landowners in the U.S. portion of the basin are USFS and the Colville Tribe. This diverse ownership is a significant factor complicating the management of the resource base in the watershed.

Fish Resources

Warm water and low velocities in the Okanogan River favor non-salmonid fishes. However, the Okanogan River (within the United States) currently supports anadromous runs of chinook salmon, sockeye salmon, and smaller runs of steelhead. Important inland species include mountain whitefish, bull trout, rainbow trout, and westslope cutthroat trout. The three major evolutionary life-history strategies exhibited by salmonids in the watershed are: ocean-type, stream-type, and resident.

Spring-Run Chinook Salmon

There are no indications that spring (stream-type) chinook salmon currently use the Okanogan drainage, but historical records indicate use of three systems: (1) Salmon Creek, prior to construction of the irrigation diversion dam (Craig and Suomela 1941), (2) tributaries upstream of Osoyoos Lake (Chapman et al. 1995a), and (3) possibly Omak Creek (Fulton 1968). There were probably several life-history strategies that historically existed in the Similkameen watershed, prior to construction of Enloe Dam in 1920, although there is no clear evidence that chinook salmon passed the natural falls on the lower Similkameen River.

Summer/Fall-Run Chinook Salmon

In general, the run strength of summer (ocean-type) chinook salmon declined slightly in the Okanogan River over a 20-year period (through the early 1990s) and increased slightly in the Similkameen River, its largest tributary, during this period (Chapman et al. 1994a). Adults enter the Okanogan River from July through late September, with the duration of spawning from late September through early November, peaking in mid-October. The spatial distribution of spawners in the watershed is fairly discontinuous. Summer-run chinook salmon spawn in limited areas between Zosel Dam and the town of Malott, a distance of about 64 miles. On the Similkameen River, summer-run chinook salmon spawn in the 9-mile span from Enloe Dam to Driscoll Island.

Emergence timing is probably January through April. Juveniles may rear from a few months to a year before migrating downstream. Juveniles generally emigrate to the ocean as subyearling fry, leaving the Okanogan River from 1 to 4 months after emerging from the gravel in April. There is evidence that some fish undergo an extended residence period, with protracted downstream movement. Many subyearlings rear in the Mid-Columbia River reservoirs.

Sockeye Salmon

The run strength of sockeye salmon to Okanogan River is highly variable; escapement has ranged from a low of 1,662 in 1994 to a high of 113,232 in 1967 (estimated from ladder counts after completion of Wells Dam). The 1986 to 1995 average run size is 28,460 fish. Osoyoos Lake is the primary rearing area for sockeye salmon in the Okanogan watershed. The lake is eutrophic, and has an abundant food supply, thereby producing relatively large sockeye salmon smolts. Sockeye salmon spawn in the mainstem Okanogan River upstream of Osoyoos Lake, between Lyons Park and McIntyre Dam, a distance of 5 miles, although some may spawn in the reach downstream of Lyons Park and in Vaseux Creek (Hagen and Grette 1994).

Spawning occurs from early October through early November, with the peak in mid-October. Adult passage through lower Okanogan River (downstream of Osoyoos Lake) may be blocked, in certain years, by warm water conditions during late July and early August (Pratt et al. 1991). Reconstruction of Zosel Dam in 1987 improved passage conditions into the lake. Sockeye salmon probably exhibited three general historical life-history strategies (anadromous sockeye, residual sockeye, and resident kokanee). All three groups appear to be closely related genetically and some hybridization likely occurs between the groups. However, the mechanism for the expression of these different life-history strategies is not well understood.

Steelhead

Very few wild steelhead currently use the Okanogan River. The historical record for steelhead in the Okanogan watershed is not complete, yet Mullan et al. (1992) assert that very few steelhead historically used Okanogan River. Salmon and Omak creeks had small runs of steelhead, but passage barriers have restricted access to each stream. Steelhead may have historically used some tributaries upstream of Osoyoos Lake (Chapman et al. 1994b). Current habitat conditions in the migration corridor are poor for most, if not all, steelhead life-history types.

Resident Salmonids

Rainbow trout appear to have one life-history pattern; to spawn and rear in the upper tributaries, including the upper Toats Coulee, and the Salmon, Omak, Sinlahekin, Bonaparte, and Tonaset Creeks. The population size and distribution of rainbow trout in these streams are not known.

The status of bull trout in the Okanogan watershed is unknown, but they are believed to be extinct downstream of Enloe and Zosel dams. Salmon and Loup Loup creeks supported bull trout populations; however, hybridization with introduced brook trout may have caused a functional extinction of these populations.

The status of cutthroat trout in the Okanogan watershed is also unknown. However, historical records indicate the presence of cutthroat in the Middle Fork Toats Coulee. It is speculated that cutthroat trout are not native to the Okanogan watershed; those currently present in Toats Coulee (and possibly Salmon Creek) may have been planted.

Habitat Conditions

The average annual flow for Okanogan River, measured at Ellisforde, is about 3,200 cfs, which is highest of the four watersheds considered in this assessment. About 75 percent of the flow comes from its largest tributary, the Similkameen River, which lies mostly in Canada. Upstream of the Similkameen confluence, the Okanogan flows through six large lakes – five of which inaccessible to anadromous salmonids and are entirely in Canada. Osoyoos Lake lies both in Canada and United States, and is used by sockeye salmon. The lower 17 miles of the Okanogan River is inundated by the Wells Dam pool.

Stream habitat conditions are fair to good in the Okanogan National Forest, and sediment delivery from this forest to lower reaches is not a significant problem. However, the lack of overhead cover, woody debris recruitment, invertebrate drift, undercut banks, and streambank stability are common in lower Okanogan River because of limited riparian vegetation in the lower river.

In the mainstem Okanogan River in British Columbia, there are 13 vertical drop structures between Osoyoos Lake and Lake Vaseaux. These structures regulate water flow for flood control and irrigation purposes, and are spaced at roughly 0.6 mile intervals. McIntyre Dam is 4.85 miles upstream of the furthest upstream structure (Vertical Drop Structure 13), and is a barrier to adult sockeye salmon migration, although some adults have been known to pass the dam in high water years. These structures limit the spawning distribution of sockeye salmon, and are suspected of contributing to the dewatering of sockeye salmon redds in winter. The reach between Vertical Drop Structure 13 and McIntyre Dam is where the majority of sockeye salmon spawn. Some sockeye salmon also spawn in Vaseaux Creek (0.9 mile below McIntyre Dam) and in the mainstem Okanogan River between Vertical Drop Structure 13 and Vertical Drop Structure 3 (6.4 miles). In low water years, passage into Vaseaux Creek may be blocked (Hansen 1993).

Zosel Dam (river mile 78) controls the level of Osoyoos Lake. Releases of water from Zosel Dam and others in the British Columbia reaches of the Okanogan River affect passage of salmonids and water quality conditions in the lower Okanogan River. Enloe Dam, located at river mile 9.5 on the Similkameen River, blocks anadromous fish passage. However, there is evidence from historical records (FERC 1980) and affidavits by the Upper Similkameen Indian Band that anadromous salmonids were blocked from upstream passage by a falls on the lower Similkameen River, which is now inundated by Enloe Dam. These records suggest that anadromous salmonids were not native to the upper Similkameen watershed.

Flows in lower Okanogan River are regulated by the series of dams in British Columbia and Zosel Dam. Water releases to meet fishery needs are negotiated yearly by a consortium of fisheries and irrigation managers from both Canada and United States. During sockeye salmon spawning, water flow from the upper Okanogan River into Osoyoos Lake is generally between 250 and 380 cfs. However, extreme flow fluctuations have occurred in the river after completion of spawning, resulting in both redd scouring and dewatering. In 1976 WDOE established base flows for Okanogan River (WAC 173-549; Table 19), and ruled that no further appropriation of surface water shall be made from Okanogan River and tributaries which would conflict with these base flows. The WDOE has established instream flow requirements for the Okanogan watershed (Chapters 173-549 WAC). These flows are used to condition new water rights, but do not affect water rights acquired prior to adoption of the instream flow rules.

Water temperatures often exceed lethal tolerance levels for salmonids in the lower Okanogan River. These exceedances are partly a result of natural phenomena (low gradient and solar radiation on the upstream lakes) but is exacerbated by sedimentation and summer low flows caused by upstream dam operations and irrigation. High water temperatures in late summer and fall effectively exclude juvenile salmonids from rearing in most of the basin, except the first few weeks after emergence. However, some limited summer rearing may occur in the Similkameen River where ground water enters the stream. At times, high water temperatures in the lower Okanogan River have blocked adult anadromous salmonid passage.

Omak Creek

The Colville Tribe collaborated with Natural Resources Conservation Service to develop a watershed plan and environmental assessment for Omak Creek (watershed size is 90,700 acres). This stream is significant to the Colville Tribe, as it is the only watershed that lies solely within the reservation. The goals of the plan are to restore over 37 miles of steelhead habitat by improving water quality, reducing soil erosion, reducing water temperatures, and eliminating man-made barriers. This last task, removal of a "velocity barrier" through a large culvert under the Omak Wood Products mill at the mouth of the creek, is the single most important means to restore natural production in Omak Creek.

Low flows (at times less than 1 cfs at the mouth) also appear to limit the production capabilities in Omak Creek. However, flows could be increased substantially if some of the water diversions are addressed. Likewise, there would be other benefits to sensitive species, and the potential for increased flows when some of the upland rehabilitation practices are implemented.

Salmon Creek

In 1916, a diversion dam was built on Salmon Creek for irrigation of about 3,000 acres of orchard and crop land. The dam, located at river mile 3, diverts all water into a 7.5 mile long ditch, which provides gravity fed irrigation water to about 300 users. The lower 3 miles of Salmon Creek is dewatered, except when excess water overflows the diversion dam during spring freshets. At other times, some groundwater surfaces into reaches of the dewatered channel, but not enough to support most aquatic biota.

The Okanogan Irrigation District manages the water supply to the irrigation ditch through controlled releases from two reservoirs–Conconully Lake and Conconully reservoir. The former feeds the latter, and both systems regulate the flows into lower Salmon Creek. From lower Conconully reservoir, Salmon Creek flows through about 12.5 miles of public and private lands before it is diverted into the irrigation channel. There is no upstream passage structure on either dam or the diversion structure. Kokanee and resident rainbow trout naturally reproduce in the two reservoirs, and support a local sports fishery.

Omak Fish Hatchery (managed by WDFW) plants catchable-size rainbow trout in these lakes. Historical records indicate bull trout were present in the North Fork Salmon Creek. In years of poor water supply from the reservoirs, the Okanogan Irrigation District pumps up to 30 cfs of water from Okanogan River near Omak to supplement the irrigation channel. This measure is done only in extreme situations, because the electrical power costs are high. Likewise, maintenance costs for the impellers are high, because of the high silt load in the Okanogan River. The life span of impellers under normal load is 1 year.

Upstream of the irrigation diversion dam (river mile 3), the average flow in Salmon Creek is 49 cfs, which could provide substantial habitat for salmon and steelhead. Habitat and water conditions upstream of the irrigation diversion dam are in fair to very good condition, depending upon the reach. Water temperatures are suitable for all stages of salmonid life history. There are numerous affidavits from early settlers of salmon and steelhead in this stream prior to dam construction. Currently, adult steelhead and spring-run chinook salmon have been observed in the lower reach of Salmon Creek when water flows to the Okanogan River confluence.

Some entities have proposed to renovate the diversion dam to provide water to lower Salmon Creek. This would require installation of a passage structure at the diversion dam and substantial changes to the irrigation system. Additionally, if sockeye salmon were to be introduced to the system, a passage structure at the landfill dam on Conconully reservoir would be required. The Okanogan Irrigation District is currently evaluating modifications to the current system to provide additional water to the lower reach of Salmon Creek.

Mainstem Okanogan River

The riparian habitat in the Okanogan is the most degraded of the four primary watersheds in the Mid-Columbia River (Chapman et al. 1994b). This lack of riparian vegetation contributes to the two major limiting factors, high water temperatures and sedimentation. Likewise, the instream habitat has the most limitations to salmonid production. Establishment of riparian and instream habitat would have limited benefits after mid-summer, because of high water temperatures. Spawning gravels are severely limited in the mainstem Okanogan River because of sedimentation. Heavy silt loads from mass failures have caused fine sediment to infiltrate redds and smother habitat for invertebrates in the Similkameen and lower Okanogan rivers. High turbidity in these reaches also reduces the feeding efficiency of juveniles.

Similkameen River

Historically, the Similkameen River was estimated to contain about 4.3 thousand acre-feet of spawning substrate, 80 percent of the total for the Okanogan watershed (Chapman et al. 1994b). Half of this habitat was estimated to lie between Palmer Creek and Keremeos, B.C. (USFWS 1985). Only the lowest 9 miles of the Similkameen River is currently available to salmonids because of Enloe Dam. However, there is some evidence that this was the upstream extent of historical anadromous fish habitat due to a reportedly impassible falls that was inundated by the dam. Some of the highest densities of summer-run chinook salmon redds in the Mid-Columbia River region have been documented in this reach of the Similkameen River (Hillman and Ross 1992).

The Similkameen River provides 75 percent of the average flows to the Okanogan basin. Like the upper Okanogan River, the Similkameen has high summer temperatures, often up to 22° C (Chapman et al. 1994b). As such, the lower Similkameen cannot support summer rearing by juvenile salmonids.

Osoyoos Lake

Osoyoos Lake is a 8 miles long, relatively shallow lake. Although the maximum depth is about 200 feet), much of the lake is less than 100 feet deep. It is very warm in the summer months, highly polluted, and appears to be in the transitory state leading to complete eutrophication (Allen and Meekin 1980). Unlike Lake Wenatchee (the other principle sockeye salmon rearing area in the Mid-Columbia River region), Osoyoos Lake is characteristic of eutrophic lakes (Mullan 1986) with shallow, warm water enriched by agricultural influences (Allen and Meekin 1980).

Osoyoos Lake is the primary rearing area for juvenile sockeye salmon in the Okanogan River system. Osoyoos Lake has a relatively abundant food source, consequently producing relatively large sockeye salmon smolts (Mullan 1986). Predators, warm water temperatures, and anoxic hypolimnentic areas may limit sockeye salmon production in the lake (Pratt et al. 1991). Eighteen species of fish inhabit the lake, and many are potential sockeye salmon predators (Chapman et al. 1995b). Water temperatures rise early in the year, reaching 18° C at the surface of the lake as early as May. In August, surface temperatures reach 25° C (Allen and Meekin 1980).

Other Lakes

There are several lakes (over 25 acres in size) in the Okanogan watershed that are currently, or were historically, blocked to anadromous fish passage. Omak Lake is a large, oligotrophic, deep alkaline lake with a high concentration of dissolved substances typical of the hard-water lakes of eastern Washington. Conductivity is generally high and has a high clarity, and high dissolved oxygen levels. Conconully, Palmer, and Spectacle lakes generally have good water quality, although algae blooms have occasionally been observed (WDOE 1976).

The Relationship of Existing Habitat Conditions to Biological Productivity

Water temperatures pose the most difficult problem for increasing survival of both ocean-type and stream-type salmonids. Chapman et al. (1994a) plotted water temperature in the Okanogan River at Oroville and Tonasket, showing that mean daily temperatures were frequently well over 21° C in 1986 and 1987 in mid-summer when sockeye salmon could be expected to migrate upstream. Hansen (1993) plotted mean daily temperatures near Zosel Dam at 21° C or higher for at least 50 days in 1992, and higher than 25° C for periods of up to 10 days. He also documented that temperatures upstream from Osoyoos Lake remained higher than 21° C for many days in July and August. Hansen (1993) speculated that the alteration of flow regimes by upstream structures have possibly changed retention times in Osoyoos Lake that exacerbate the problem.

Ocean-type Salmonids

The high temperatures in the lower Okanogan River could force ocean-type chinook salmon subyearlings to remain well upstream in cooler areas or leave the Okanogan watershed for the Columbia River before the high temperatures begin to develop. Spawning habitat for ocean-type chinook salmon is highly degraded, but still supports a viable population. Progeny of chinook salmon spawners in the Similkameen River must emigrate as subyearlings to maintain viability.

Stream-type Salmonids

Sockeye salmon production is spawning habitat limited (Allen and Meekin 1980; Mullan 1986; Chapman et al. 1995b), and flow conditions in lower Okanogan River (downstream of Osoyoos Lake) as well as related elevated temperatures in the lake and river have been shown to adversely affect adult survival. The estimated carrying capacity is about 4 million smolts, substantially higher than the current production (from 0.5 million to 2.0 million) (Pratt et al. 1991).

Predators, warm water temperatures, and anoxic hypolimnentic areas may limit sockeye salmon production in Osoyoos Lake (Pratt et al. 1991). Recent dissolved oxygen and temperature profiles of Osoyoos Lake (Rector 1993) indicate the formation of a strong thermocline in summer months that persists until fall turnover. Thermoclines of this magnitude result in large portions of the lake not being conducive for rearing of sockeye salmon fry and limit its rearing capacity (Pratt et al. 1991).

Correcting fish passage problems in Salmon and Omak creeks would substantially increase the production capabilities of the system for spring-run chinook salmon and steelhead compared to existing conditions.

3.3 WATER RESOURCES (QUANTITY AND QUALITY)

Key Terms

303(d) List - A list of water bodies that the WDOE has identified as having impaired water quality based on evidence that specific water quality standards have not been met. Section 303(d) of the Federal Clean Water Act requires that states prepare and periodically update these lists and develop controls to bring the water bodies into compliance with standards and protect beneficial water uses (e.g., water supply, cold water fisheries, etc.). Hundreds of creeks and river segments in Washington are currently on the 303(d) list.

Base Flow - The normal low flow that occurs seasonally in a river or creek. During a period of run-off from rain or snowmelt, streams rise above base flow levels and then recede to base flows sometime after the runoff event has passed. Base flows are sustained by groundwater discharges that may vary seasonally (e.g., higher base flow in the spring and lower in the summer).

Dissolved Oxygen - The amount of oxygen that is in solution. Compared to warm-water fish (e.g., large mouth bass or catfish), cold-water fish (e.g., salmon and trout) require relatively high levels of oxygen for respiration. Water quality standards for dissolved oxygen are minimum concentrations to protect cold-water fisheries.

Flow (or Discharge) - A measurable quantity of water passing through a dam or a reach of river over a given period of time. Flows for rivers in the United States are commonly reported in cfs.

Instream Flow - The amount of water in a river or creek required to sustain fisheries and water quality needs. Fisheries biologists and hydrologists have developed a model called the "instream flow incremental methodology", which is applied to streams to determine the flows needed for fish habitat.

Run-of-the-River Hydroelectric Project – The Wells, Rocky Reach, and Rock Island hydroelectric projects are run-of-the river projects, which means that they do not store substantial amounts of water in their reservoirs. Run-of-the-river hydroelectric projects produce electric power through use of the gravitational force of falling water, and consist of a powerhouse, spillway and embankments, as well as fish passage facilities.

Key Terms (continued)

Total Dissolved Gas – Total dissolved gas is the amount of all gases that are in solution (e.g., nitrogen, carbon dioxide, oxygen, etc.). "Supersaturation" occurs when water is aerated to the degree that dissolved gases in the water exceed equilibrium conditions for saturation. High levels of supersaturation are harmful to fish; therefore, water quality standards for total dissolved gas are maximum concentrations.

Tributaries - Smaller streams or rivers that enter larger water bodies. For example, the Wenatchee River is a tributary of the Columbia River and Icicle Creek is a tributary of the Wenatchee River.

Turbidity - A measure of the cloudiness or opaqueness of water. In other words, muddy water has high turbidity and clear water has low turbidity. Turbidity is measured by an instrument that passes a beam of light through a water sample and measures the degree to which the light is scattered by suspended particles.

Water Quality Standards – These standards define the minimum requirements to protect beneficial uses of rivers, creeks, lakes, and other water bodies and are required by the federal Clean Water Act for all states to establish and enforce. The current Water Quality Standards for Surface Waters of the State of Washington (Chapter 173-201A of the Washington Administrative Code) designate water bodies as "Class AA" (extraordinary), "Class A" (excellent), or other classes. Each class has numerical and narrative standards to protect general beneficial uses, with Class AA having the most stringent standards. In the future, the standards will be changed to identify specific beneficial uses for each water body. Similar to State standards, Tribes administer water quality standards on their lands.

Water Rights - Water rights permits are required from the WDOE to withdraw water from rivers, creeks, lakes, or groundwater resources. These permits specify where, when, and how much water may be withdrawn. In many areas of the State, water rights have been over-allocated to the point that there is not enough water to both meet the demands of water rights applicants and sustain water quality and fisheries needs.

* *See Chapter 6 for a complete listing of all Key Terms.*

3.3.1 WATER QUANTITY

Water quantities in the Mid-Columbia River and its tributaries are important to fish, wildlife, and people. The salmonid life cycles are closely tied to the annual water cycle, with juvenile outmigration occurring during spring high flows. High flows help the young fish reach the Pacific Ocean quickly, thereby minimizing predation and other causes of mortality in the river. Maintaining adequate summer low flows is also critical to the success of salmon and steelhead spawning and rearing in small tributary channels.

3.3.1.1 Project Area

The Columbia River is primarily fed by snowmelt. Snow accumulates in the higher elevations from fall through early spring, then melts producing run-off during late spring and summer. High run-off occurs when the snow is melting during May and June, with streamflows typically reaching their peaks in early June. These high flows are critical to the efficient outmigration of juvenile salmonids. In late summer and fall, the river flows recede and generally remain low through April. Rainfall occasionally increases the run-off, and rain-on-snow events have caused some of the largest floods in the Mid-Columbia River.

Columbia River basin hydropower projects fall into two major categories: storage and run-of-river. Storage projects such as Grand Coulee Dam have a large operating range between minimum and maximum pool elevations, store large volumes of runoff water and shape downstream flows by gradually releasing the stored water.

The releases from Grand Coulee Dam and regulation by Chief Joseph Dam fundamentally effect the magnitude and timing of flows at downstream run-of-river dams. Since Grand Coulee Dam is not equipped with selective depth-withdrawal facilities, downstream water temperatures depend on the depth of the Lake Roosevelt thermocline.

Operating plans for the storage facilities are implemented by Federal agencies according to the Columbia River Treaty with Canada. Grand Coulee releases water from August through December to meet energy demands, draws down the reservoir from January through mid-April for flood control and power production, and refills the reservoir from mid-April through June. Beginning in 1983, water was also released in the spring to aid downstream migration of juvenile anadromous salmonids.

The Mid-Columbia River dams and other run-of-river projects have a small operating range, little storage capacity, and must pass inflow through the reservoirs most of the time. The utility districts record daily measurements of the water quantity or flow passing each of these dams.

Wells Dam

Douglas County PUD records daily measurements of flow through turbines plus spillway flow, when present, at Wells Dam. Average monthly flows range from 114,791 cfs in September to 120,546 cfs in July (Figure 3-5) (WDOE 2000). A maximum discharge of 402,000 cfs was reported for June 15, 1972.

Wells Dam has a somewhat broader range of normal pool elevations ranging from 771 to 781 feet than the other Mid-Columbia River projects. The existing FERC license allows a minimum elevation of 767 feet, if requested by the Army Corps of Engineers for flood control, and a maximum pool elevation of 791 feet during a "flood of record" spill event (Beak 1996). The most recent license settlement agreement includes criteria for spill bypass operations to enhance juvenile fish passage (FERC 1991).

Rocky Reach Dam

Similar to Rock Island Dam, Chelan County PUD records daily measurements of flow through the turbines plus spillway flow, when present (Wiggins et al. 1997). These measurements have been recorded continuously since October 1960. Average monthly flows range from 83,824 cfs in October to 136,147 cfs in June (Figure 3-6) (WDOE 2000). A maximum discharge of about 535,000 cfs was reported for June 10, 1961. These measurements are a requirement of the original FERC license for Rocky Reach (FERC 1957a).

Similar to Rock Island, Rocky Reach Dam normally fluctuates the forebay elevation only 4 feet (i.e., 703 to 707 feet elevation) with a maximum range from 703 to 710 feet (FERC 1957a).

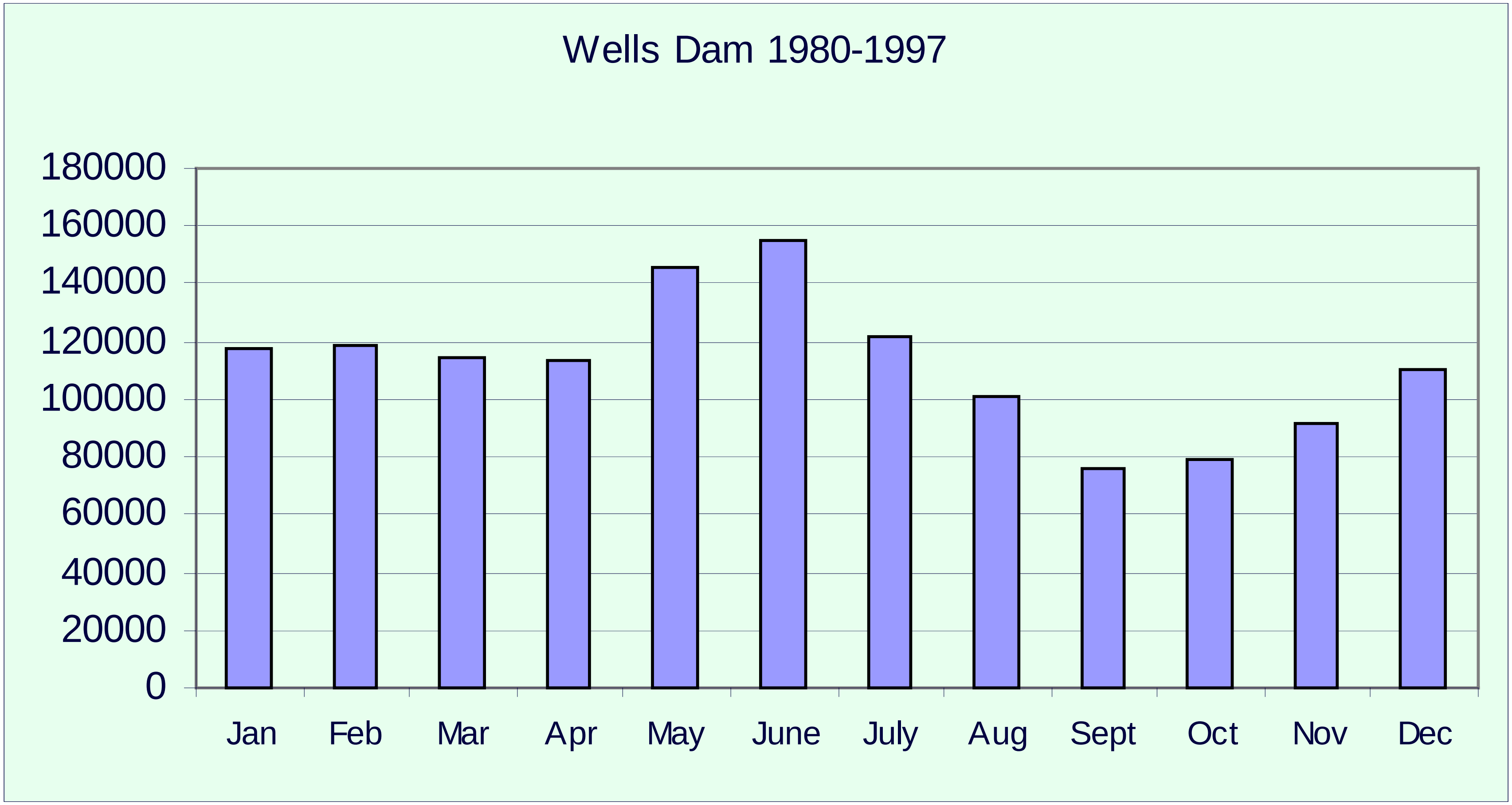
Rock Island Dam

Since June 1961, Columbia River discharge has been measured daily by Chelan County PUD at Rock Island Dam as the flow through turbines plus spillway flow, when present (Wiggins et al. 1997). Previous measurements were limited to water level records. Average monthly flows range from 74,478 cfs in September to 162,228 cfs in June (Figure 3-7) (Williams and Pearson 1985). A maximum discharge of 692,600 cfs was recorded for June 12, 1948 (Wiggins et al. 1997). From flood marks at Wenatchee, Washington, the flood of June 7, 1894 was estimated to have reached a peak discharge of 740,000 cfs. The minimum recorded flow is 4,120 cfs from February 10, 1932 (FERC 1988).

As a run-of-river project, the Rock Island Dam has very limited capabilities for raising and lowering reservoir water levels. Forebay water levels generally fluctuate between 609 and 614.1 feet elevation, with a maximum range of 602.9 to 619.5 feet (FERC 1989b). The normal operating range is only exceeded during unusual circumstances (e.g., if spill requirements exceeded reservoir inflows for an extended time period).

3.3.1.2 Associated Tributaries

The USGS operates stream-gauging stations on the Wenatchee, Entiat, Methow, and Okanogan rivers and some of their tributaries. The relatively arid conditions in watersheds on the east side of the



Parametrix, Inc. Mid Columbia/553-1543-020 (10) 1/00 (K)

Figure 3-5
Average Monthly Flow (cfs) in the
Mid-Columbia River at Wells Dam

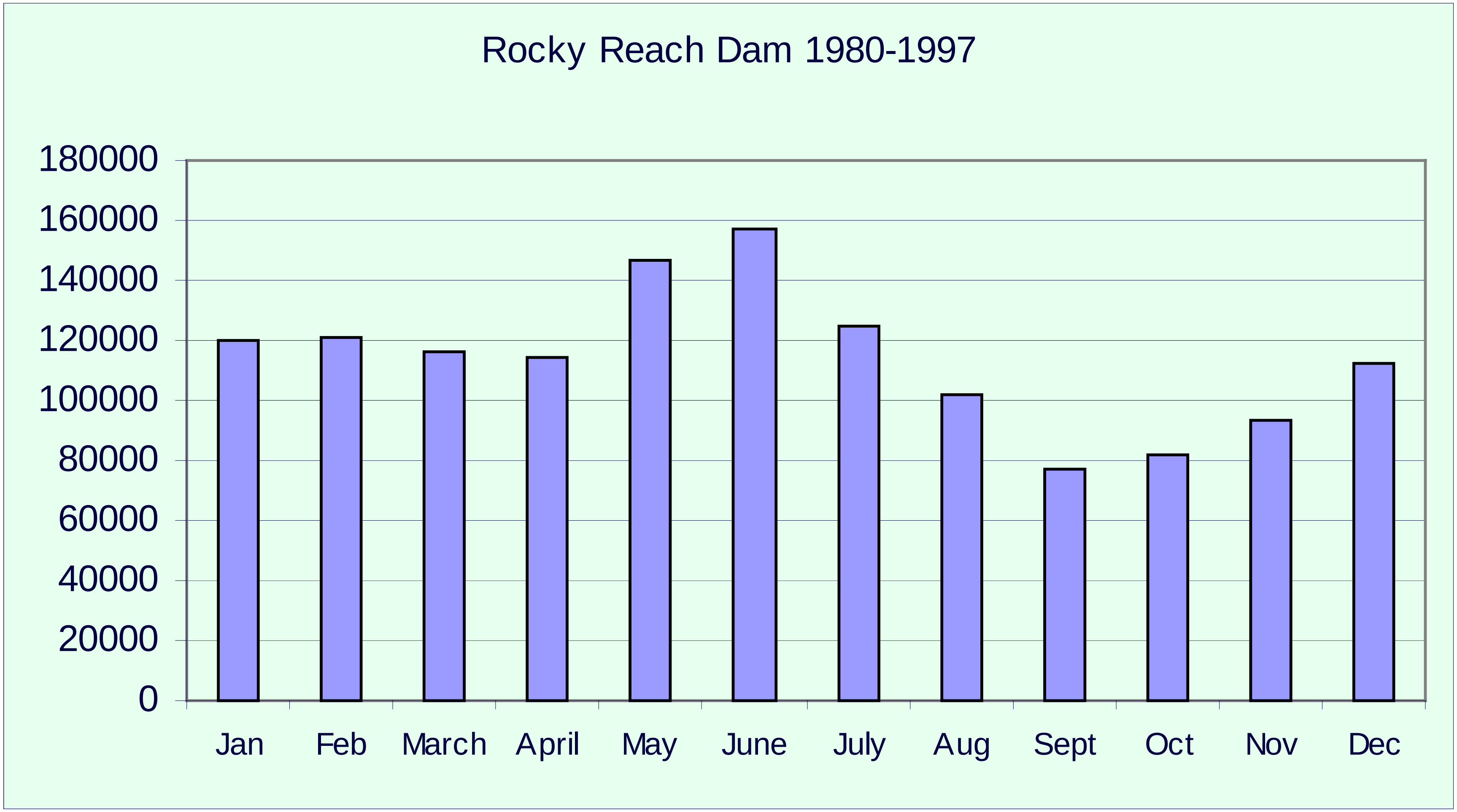
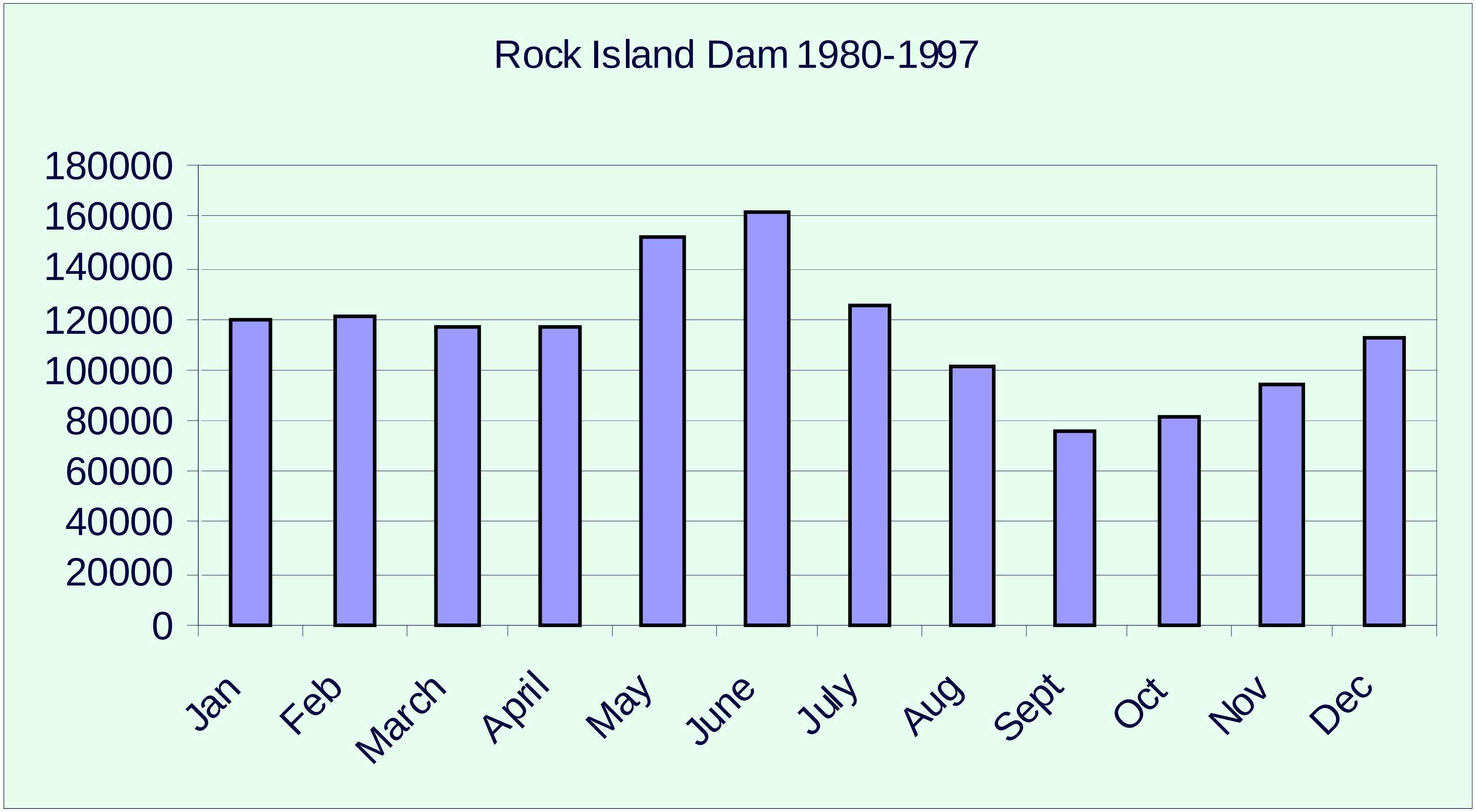


Figure 3-6
Average Monthly Flow (cfs) in the
Mid-Columbia River at Rocky Reach Dam



Parametrix, Inc. Mid Columbia/553-1543-020 (10) 1/00 (K)

Figure 3-7
Average Monthly Flow (cfs) in the
Mid-Columbia River at Rock Island Dam

Cascade range, combined with the demand for water supplies for irrigation and other uses, result in low flows that affect fish in many of these streams.

Using instream flow incremental methods and data from other hydrologic studies, WDOE has determined that beneficial uses (i.e., fisheries) of many Mid-Columbia River tributaries are impaired due to insufficient instream flows.

To comply with Section 303(d) of the Clean Water Act, WDOE has placed these tributaries on a list of impaired water bodies (i.e., the 303[d] list) and is developing controls to restore beneficial uses (WDOE 1998a). The latest 303(d) list for the State of Washington was updated by WDOE in 1998 and submitted to the USEPA for approval. As part of the response to critical low flows in Mid-Columbia River tributaries, WDOE is not permitting new water rights to withdraw water from several of the Mid-Columbia River tributaries.

Fish hatcheries and other artificial propagation facilities associated with the Mid-Columbia River and its tributaries withdraw water from the rivers primarily for non-consumptive uses. The water is returned close to the point of withdrawal so these facilities have a negligible effect on instream flows.

Wenatchee River

The Wenatchee River flows from the east slope of the Cascade mountains in Chelan County and enters the Columbia River approximately 5 miles downstream from the Rocky Reach Dam (see Figure 2-2). The Wenatchee River watershed drains 1.328 square miles with 231 miles of major streams (NMFS et al. 1998a). Major tributaries include the Little Wenatchee, White, and Chiwawa rivers; and Nason, Icicle, Chumstick, and Peshastin creeks.

Although the Wenatchee River watershed is only the third largest of the four major Mid-Columbia River tributaries, it produces the greatest average annual discharge (2.3 million acre-feet, [NMFS et al. 1998a]). Average monthly flows range from less than 836 cfs in September to more than 9,043 cfs in June (Figure 3-8, [Williams and Pearson 1985]). Snowmelt is the primary source of the high flows seen in late spring and early summer. However, the maximum recorded discharge for the Wenatchee River (47,500 cfs) occurred on November 30, 1995, in response to a rain-on-snow event (Williams and Pearson 1985). Effects of the large forest fires of 1994, including reduced evapotranspiration and soil absorption capacity, likely contributed to this high peak flow, and may continue to increase total river discharge for an undetermined time (Wenatchee River Watershed Steering Committee/Technical Advisory Committee 1996). In dry years, September flows have averaged as low as 346 cfs.

Of the 420 cfs total water rights established in the Wenatchee River watershed, irrigation districts own about 68 percent (NMFS et al. 1998a). Other water uses are domestic (10 percent), commercial and industrial (8 percent), municipal (6 percent), fish hatcheries (3 percent), and others (4 percent). There are four major irrigation districts in the Wenatchee River watershed: (1) Wenatchee Reclamation District, (2) Icicle and Peshastin Irrigation Districts, (3) Cascade Irrigation District, and (4) Chiwawa Irrigation District, together with two smaller irrigation groups (Jones-Shotwell and Pioneer-Gunn). Wenatchee Reclamation District, the largest user, diverts up to 200 cfs from the Wenatchee River at Dryden.

WDOE established minimum instream flows for the Wenatchee River and some of its tributaries, to protect and preserve instream values, such as fish and wildlife habitats (NMFS et al. 1998a). These flows are used to condition new water rights issued by WDOE. Because data indicate that minimum instream flow requirements (e.g., 1,200 cfs at Peshastin and 2,000 cfs at Monitor) are not met 90 percent of the time from August to October, WDOE placed the Wenatchee River on its 303(d) list as impaired due to inadequate instream flows (WDOE 1998a). In years of low snowpack, water withdrawals for irrigation and other uses may impact salmonid spawning and rearing habitat.

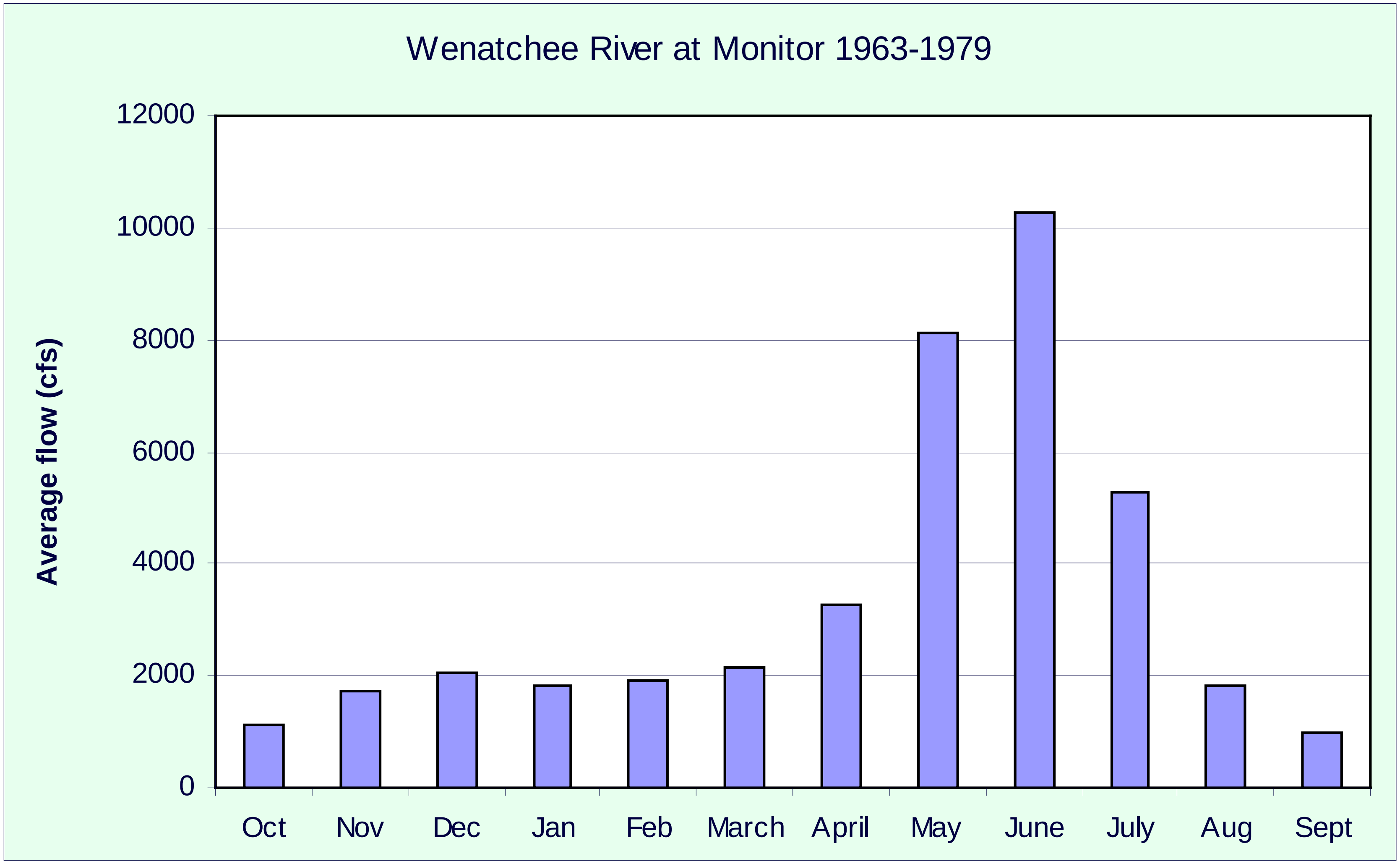


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Figure 3-8
Average Monthly Flow in the
Wenatchee River at Monitor, Washington

Several tributaries of the Wenatchee River have also been placed on the 303(d) list as impaired due to inadequate instream flows (WDOE 1998a). Icicle Creek instream flow requirements are not met for an average of 66 days from August to October due to water withdrawals for irrigation, the Leavenworth Fish Hatchery, and the town of Leavenworth. Measurements of essentially zero flow in Chumstick Creek were attributed to large irrigation diversions. Existing water right users, such as the Peshastin Irrigation District, divert enough water to dry up Peshastin Creek in late summer and early fall. Similarly, diversions from Mission Creek were deemed responsible for the lack of flows in Mission Creek. WDOE is responsible for developing controls that restore habitat for spring-run chinook salmon and steelhead in these streams.

Entiat River

The Entiat River flows between the Entiat River and Chelan mountains on the east slope of the Cascade range in Chelan County, and joins the Columbia River 10 miles upstream from Rocky Reach Dam. The Entiat River watershed drains 419 square miles (Williams and Pearson 1985). Approximately one-fourth of this area is the Mad River watershed, the only major tributary of the Entiat River.

The Entiat River watershed is the smallest of the four major Mid-Columbia River tributaries addressed in the HCP. Average monthly flows in the lower river near Entiat River, range from less than 1,180 cfs in October to more than 9,400 cfs in June (Figure 3-9) (Wiggins et al. 1997). Snowmelt is the primary source of the high flows seen in late spring and early summer. A maximum discharge of 6,430 cfs was recorded at the upper Entiat River gauging station on June 10, 1972 (Williams and Pearson 1997), and the maximum flow in the lower river likely exceeded 8,000 cfs at that time[2]. In dry years, monthly flows have averaged as low as 60 cfs (Wiggins et al. 1997).

In complying with Section 303(d) of the Clean Water Act, WDOE has listed the lower 10 miles of the Entiat River as impaired because of insufficient instream flows to maintain fishery resources (WDOE 1998a). And as a result of instream flow incremental methodology modeling of fish habitat at different instream flow levels, WDOE recommended base flows in the lower Entiat River ranging from 185 cfs from July 1 to March 15, to 325 cfs from April 16 to May 31 (Kirk et al. 1995). However, stream gauging records indicate that river flows are generally below the recommended levels from September 1 to mid-April. Minimum flow recommendations for the Entiat River have not yet been codified into regulations.

Instream flow incremental methodology studies also showed that instream flows in the upper Entiat River are inadequate from August 1 to May 1. However, because there are no diversions in the upper watershed and low flows are a natural condition there, the upper reach was not placed on the 303(d) list.

More than 90 percent of the Entiat River watershed is in public ownership (NMFS et al. 1998a); however, irrigation withdrawals from the lower river and its tributaries contribute to inadequate streamflows. A Wenatchee National Forest watershed assessment indicated that natural characteristics of the watershed and human modifications of the lower Entiat River stream channel have also contributed to the lack of water retention in the river (USFS 1996). WDOE will be evaluating the importance of instream flow levels to fish in the Entiat River, to resolve water rights claims and determine a process to restore and maintain desirable instream flows.

[2] Flow gauging in the lower Entiat River was discontinued between 1958 and 1996; thus, the maximum flow during the 1972 peak was estimated. Average monthly flows for the lower Entiat River are based on the records for 23 years between 1911 and 1958.

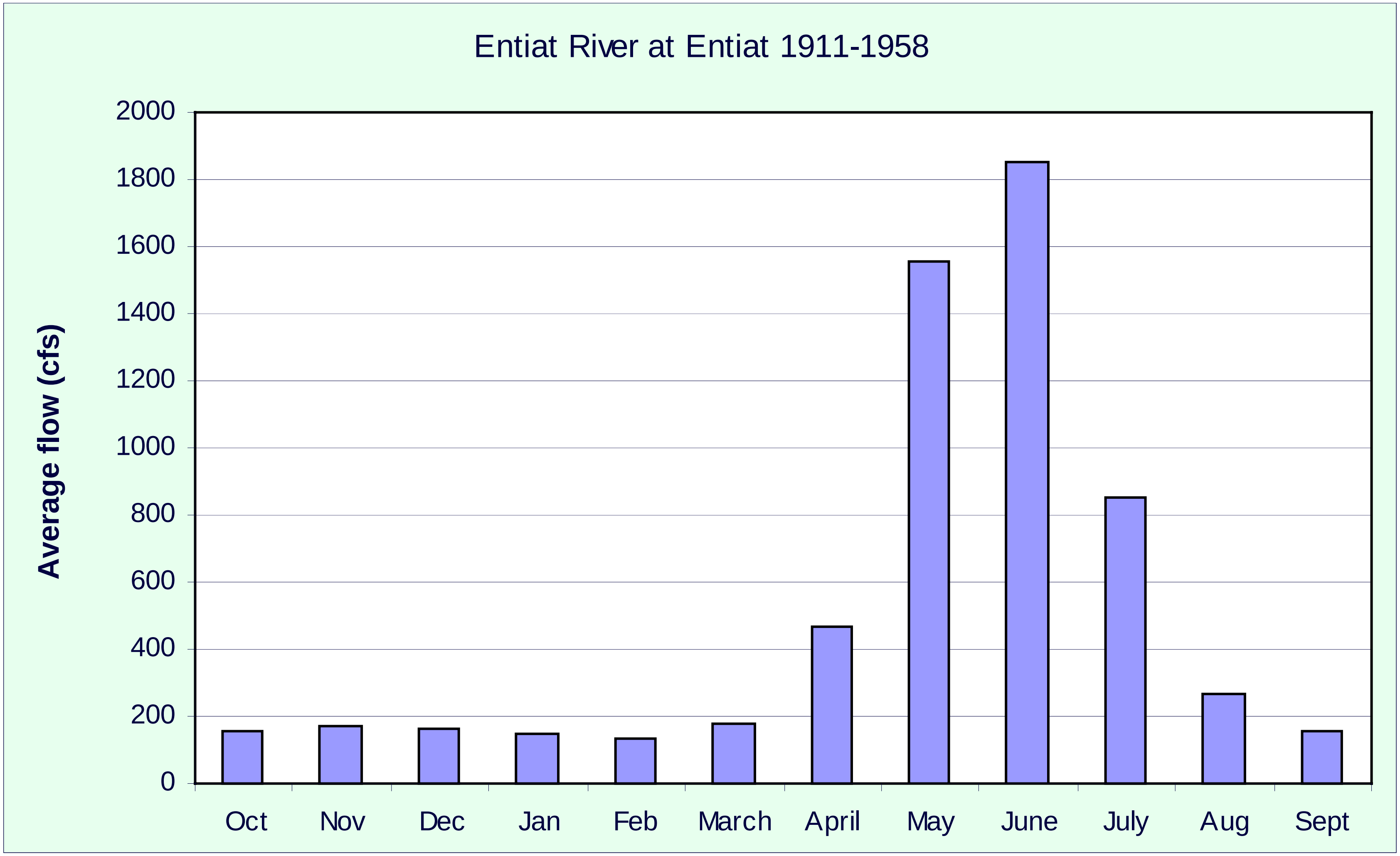

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Figure 3-9
Average Monthly Flow in the Entiat River at Entiat, Washington

Methow River

The Methow River originates in the Okanogan National Forest and Pasayten Wilderness on the east slope of the Cascade range in Okanogan County, and flows southeast to the Columbia River at Pateros, Washington (see Figure 2-4). The Methow River watershed drains 1,792 square miles. Two major tributary watersheds, the 245 square miles Twisp River watershed and the 525 square miles Chewuch River (formerly named the Chewuck River) watershed (Wiggins et al. 1997) encompass more than 40 percent of this area.

Average monthly flows in the Methow River near Pateros, Washington range from 424 cfs in January and February to 5,963 cfs in June (Figure 3-10) (Wiggins et al. 1997). Similar to the other major Mid-Columbia River tributaries, snowmelt is the primary source of the high flows seen in late spring and early summer. The maximum measured discharge was 28,800 cfs in May 31, 1972; however, a peak discharge of 46,700 cfs was estimated for May 29, 1948. In dry years, monthly flows have averaged as low as 237 cfs (Wiggins et al. 1997).

WDOE found that instream flows limit salmonid production in the Methow River and its tributaries at virtually all freshwater stages of their life cycle (Caldwell and Catterson 1992). Therefore, WDOE placed four reaches of the Methow, Twisp, and Chewuch rivers, and Beaver, Early Winters, and Wolf creeks on the 303(d) list of water quality limited streams because of low instream flows. WDOE also established instream flow requirements for the Methow River watershed to limit any new water rights (NMFS et al. 1998a).

Although only 6 percent of the Methow River watershed are private property, including 12,800 acres of irrigated cropland (NMFS et al. 1998a), the effect of irrigation on instream flows is considered more acute than in other Mid-Columbia River tributaries (Methow Valley Water Pilot Planning Project Committee 1994). Up to 90 percent of instream flow withdrawals (248.2 cfs) are used for agricultural irrigation (NMFS et al. 1998a). WDOE estimated that ditches remove about 50 percent of the river flow from the Methow River and most of the flow from some tributaries, in late summer and fall. In summary, hydrologic studies suggest that irrigation diversions exacerbate the problem of critically low flows that occurs naturally in the Methow River watershed.

Okanogan River

The Okanogan River originates in British Columbia, flows through several large lakes, and enters the Columbia River approximately 11 miles downstream from Chief Joseph Dam (see Figure 2-5). The largest of the Mid-Columbia River tributaries, the Okanogan River drains a watershed of approximately 8,080 square miles (Wiggins et al. 1997). Approximately one-half of this area lies within the Similkameen River watershed, an international river system that joins the Okanogan about 5 miles downstream from Osoyoos Lake and supplies approximately 75 percent of the Okanogan River flow below the confluence.

Flows in the lower Okanogan River are partly regulated by water releases from Zosel Dam and other dams in British Columbia. These releases are negotiated yearly by an international consortium of fisheries and irrigation managers (NMFS et al. 1998a). Although water flows from the upper Okanogan River into Osoyoos Lake are generally maintained between 250 and 380 cfs during sockeye salmon spawning, extreme flow fluctuations after spawning have resulted in both redd scouring and dewatering. The pool formed by Wells Dam on the Columbia (NMFS et al. 1998b) inundates the lower 17 miles of the Okanogan River.

Average monthly flows in the lower Okanogan River at Malott, Washington range from 1,135 cfs in October to 10,330 cfs in June (Figure 3-11) (Wiggins et al. 1997). Snowmelt is the primary source of the high flows seen in late spring and early summer. The maximum discharge was 45,600 cfs on June 3, 1972. In dry years, monthly flows at

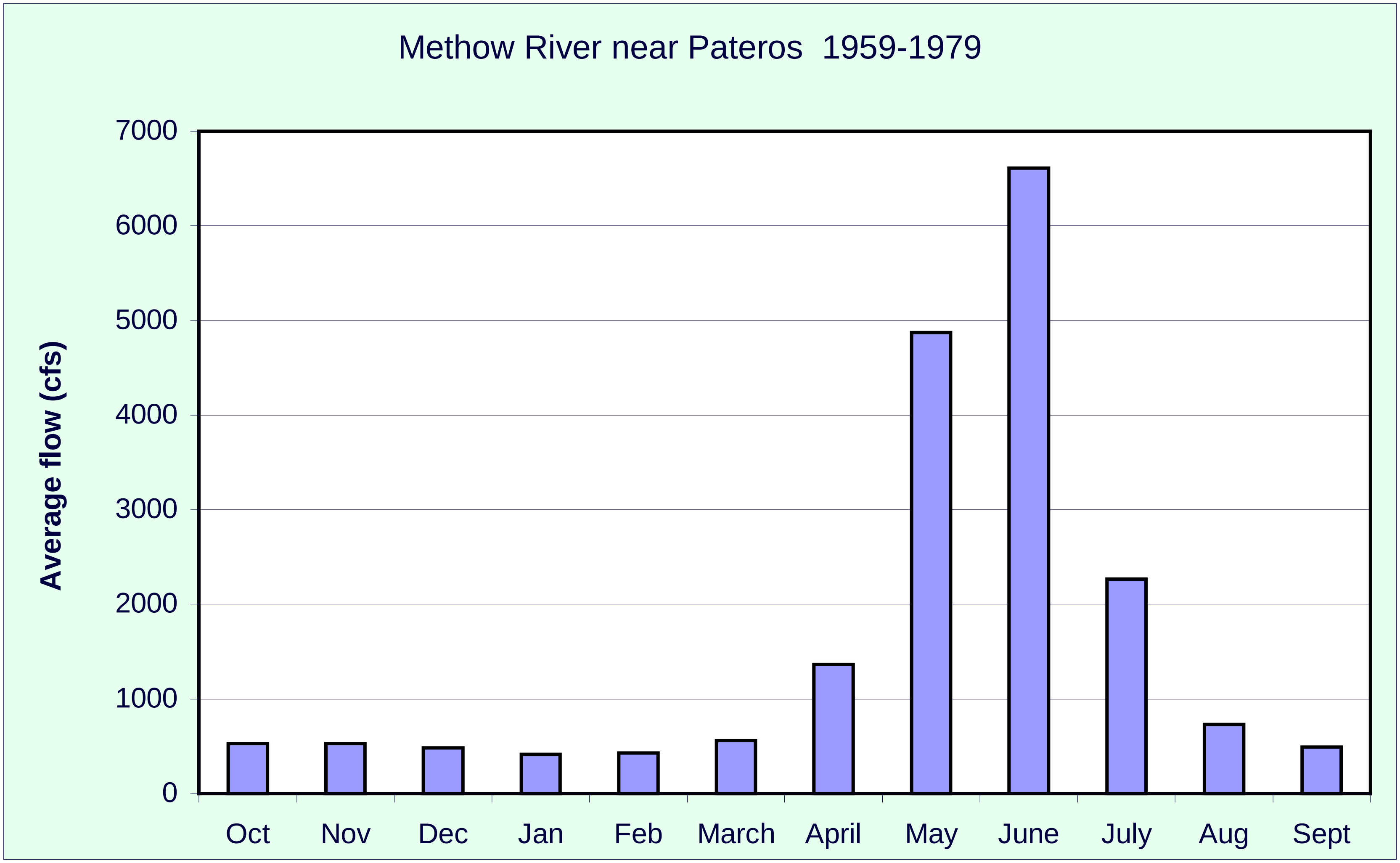

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Figure 3-10
Average Monthly Flow in the Methow River at Pateros, Washington

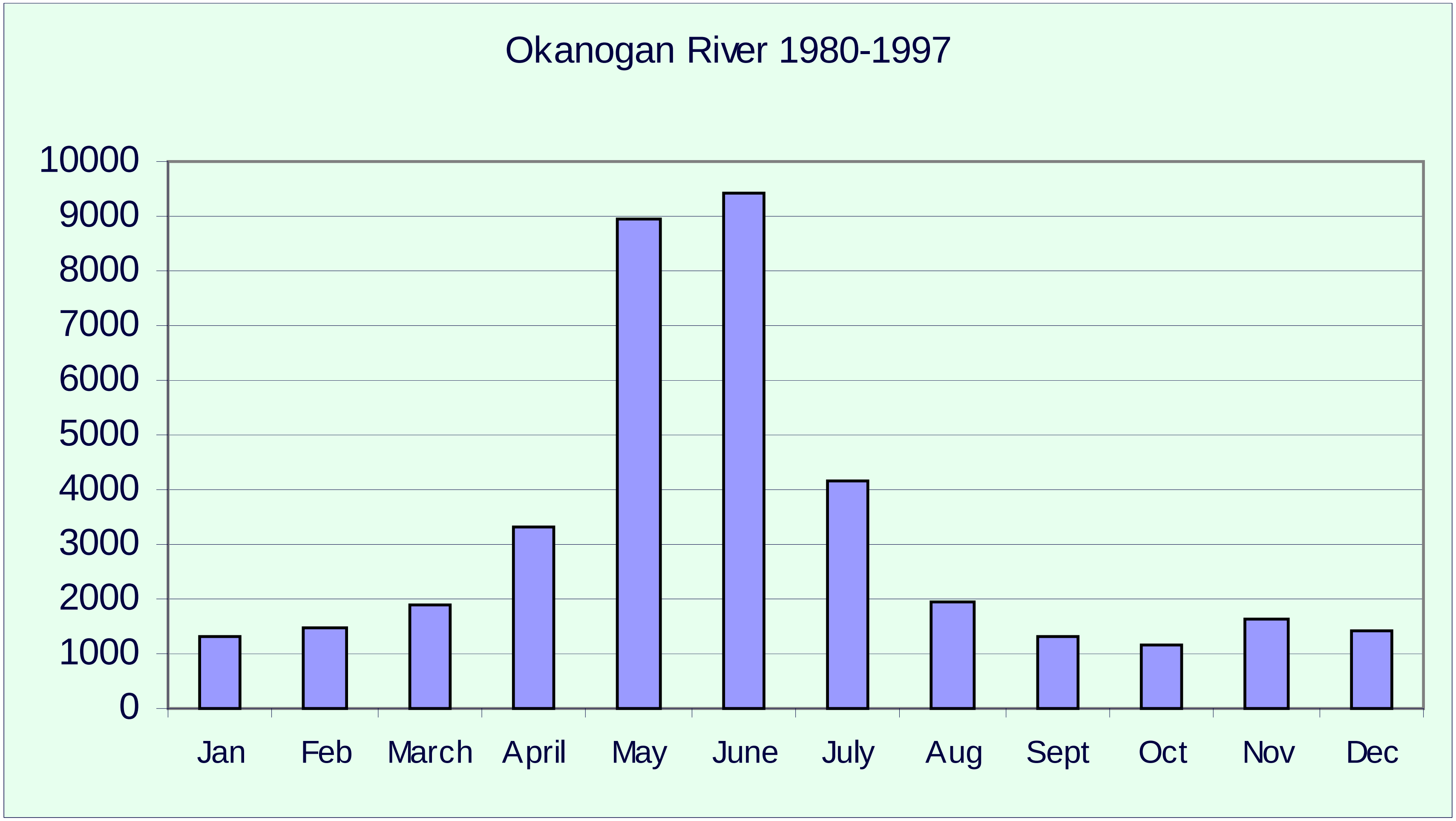

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Figure 3-11
Average Monthly Flow (cfs) in the
Okanogan River at Malott, Washington

Malott have averaged as low as 372 cfs in September (Wiggins et al. 1997).

In 1976, WDOE established base flows for the Okanogan River, and ruled that no further appropriation of surface water from the river and its tributaries shall be made which would conflict with these base flows (NMFS et al. 1998b). They further determined that, except for livestock watering and domestic uses, no additional appropriations of water from lakes would be granted. Lower Okanogan River flows drop below the minimum base flows established for late August and September (i.e., 800 cfs), during dry years.

Salmon Creek, a tributary that enters the river at Okanogan, Washington, was placed on the 303(d) list as impaired due to inadequate instream flows. In making this determination, WDOE cited studies showing that irrigation diversions can completely dry up the creek and flow can be zero from February to September, resulting in the total loss of salmon and steelhead runs in the stream.

3.3.1.3 Columbia River System

The Columbia River system drains an area of 259,000 square miles (FERC 1996a). The three project area dams form run-of-the-river reservoirs that have a limited effect on river flows compared to several upstream dams that are operated, in part, for flood control. Wells, Rocky Reach, and Rock Island dams are relatively low dams that were designed for hydropower production and have very little capacity to impound water for flood control. Chief Joseph Dam, immediately upstream from the project area, and other Federal dams on the lower Columbia River are also run-of-the-river dams (BPA et al. 1995a).

Upstream Federal storage dams operated for flood control are Grand Coulee on the upper Columbia, Albeni Falls on the Pend Oreille River, Libby on the Kootenai River and Hungry Horse on the Flathead River. Coordinated flow release schedules for the Federal Columbia River Power System are established each year in Watershed Management Plans. Grand Coulee Dam has the capacity to store 5.19 million acre-feet of water in Lake Roosevelt. As the largest source of water to the Mid-Columbia River, releases from Lake Roosevelt at Grand Coulee Dam have a substantial impact on Mid-Columbia River flows directly downstream.

3.3.2 WATER QUALITY

The Mid-Columbia River has been designated a "Class A", or excellent quality water body (Chapter 173-201A WAC). Reaches of the four major Mid-Columbia River tributaries studied were classified by WDOE as either Class A or Class AA (extraordinary) waters. Class AA designations apply to the Wenatchee River from the Wenatchee National Forest boundary to its headwaters, the Little Wenatchee, White, Chiwawa, and Entiat rivers from the Wenatchee National Forest to its headwaters, the Methow River upstream from its confluence with the Chewuch and Twisp rivers. Characteristic protected uses of Class A and Class AA waters include water supply (domestic, industrial, and agricultural); stock watering; fish and shellfish rearing, migration, spawning, and harvesting; wildlife habitat; recreation; and commerce and navigation.

Salmon and steelhead rearing, migration, and spawning in the Mid-Columbia River and its tributaries are the beneficial water uses most sensitive to water quality. High water temperatures may delay the return of adult salmonids to spawning grounds and cause mortality of juvenile fish rearing in small tributary streams. High water temperatures and low flows may also cause stress or mortality of rearing salmonids due to reduced dissolved oxygen levels in tributaries. Mid-Columbia River salmon and steelhead are also sensitive to high levels of dissolved gas that can lead to gas bubble diseases during high spill periods.

Water quality standards for Class A waters (Chapter 173-201A WAC) include limits for fecal coliform organisms (geometric mean less than 100 colonies per 100 milliliters), dissolved oxygen (minimum requirement of 8.0 milligrams per liter), and total dissolved gas (total dissolved gas, maximum of 110 percent saturation). Temperature (maximum of 18.0ºC due to human activities), pH (acceptable range of 6.5 to 8.5), and turbidity (no increase of 5 nephelometric turbidity units [NTUs] if background is less than 50 NTU, or less than a 10 percent change if background is greater than 50 NTU) are additional water quality standards that apply to the project area waters.

There are also established limits to concentrations of toxic, radioactive, or deleterious material below levels that have the potential to adversely affect water use, biota, or public health. Further, aesthetic values should not be impaired, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

Class AA water quality standards (Chapter 173-201A WAC) are more stringent for some specific parameters compared to Class A standards. Fecal coliform shall not exceed a geometric mean value of 50 colonies per 100 milliliters, dissolved oxygen shall exceed the 9.5 milligrams per liter minimum, and water temperature shall not exceed 16.0º C due to human activities.

To comply with Section 303(d) of the Clean Water Act, WDOE has compared existing water quality data to State standards (WDOE 1998a). As a result, several Mid-Columbia River reaches and tributaries were placed on a list of water quality limited water bodies (i.e., the 303[d] list) in 1996. The latest 303(d) list for the State of Washington was updated by WDOE in 1998 and submitted to the USEPA for approval. WDOE is developing total maximum daily loads (total maximum daily loads) for the specific water quality parameters that exceed standards. Total maximum daily load studies will include discharge limits for pollutant sources aimed at compliance with water quality standards and beneficial use restoration and protection.

Total dissolved gas supersaturation is the foremost water quality concern in the Mid-Columbia River. Total dissolved gas supersaturation in the Mid-Columbia and Snake rivers was identified in the late 1960s and 1970s as detrimental to salmon, and those concerns have reappeared as reservoir management agencies have reinstituted spill as a means to aid fish passage at hydropower facilities (NMFS 1995). Total dissolved gas supersaturation is a condition that occurs when atmospheric gases are forced into solution at pressures that exceed the pressure of the overlying atmosphere. Water containing more than 100 percent total dissolved gas is in a supersaturated condition.

Supersaturation may occur through natural or dam-related processes that either increase the amount of air dissolved in water or reduce the amount of air the water will hold.

Total dissolved gas supersaturation in the Mid-Columbia River is well documented and has been linked to salmon and steelhead mortality and migration delays (Beiningen and Eloe 1970; Ebel et al. 1975; Gray and Haynes 1977; BPA et al. 1995a). Fish that are exposed to excessive total dissolved gas supersaturation can develop gas bubble disease, a harmful and often fatal condition.

Total dissolved gas supersaturation varies substantially by season and by dam (BPA et al. 1995a). Total dissolved gas supersaturation in the Mid-Columbia River during periods of high run-off and spill at hydropower facilities occurs primarily because of entrainment of gases when turbulent water plunges deeply in the tailrace pools. Passing water through turbines does not increase gas saturation appreciably (BPA et al. 1995a). Most total dissolved gas variation just downstream of spillways is explained by the variation in spill rates and spillway plunge depth, spill pattern and gas abatement structures and operations.

In addition to depth and pressure, total dissolved gas supersaturation is affected by water temperature. As water temperature increases, the amount of dissolved gas that can be held in solution decreases, resulting in higher total dissolved gas levels when dissolved gas concentrations remain constant. This temperature effect is important in the Mid-Columbia River where temperatures vary daily and seasonally during salmon and steelhead migrations, and where temperature regimes have been altered by hydropower projects (Beiningen and Ebel 1970). During the spring and summer, water temperatures in the Mid-Columbia River increase from about 6°C to about 18°C. Within this temperature range, an increase in temperature of 1°C will result in an increase of about 2 percent of total dissolved gas saturation (Colt 1984).

Although extensive evaluations have been conducted under controlled or laboratory conditions, the effects of specific total dissolved gas levels on fish in a river environment is relatively unknown. Based on the overall benefits of spilling water to pass juvenile fish in the Columbia and Snake rivers, WDOE grants "approval to spill", thereby allowing slight exceedances of the total dissolved gas standard. Although the State water quality standard for total dissolved gas is set at 110 percent of saturation, the waiver stipulates that total dissolved gas should not exceed 115 percent in the forebay and 120 percent in the tailrace of Columbia and Snake river dams (Koehler and McDonald 1997).

3.3.2.1 Project Area

The Mid-Columbia River is relatively unpolluted and has few sources of wastewater or other pollution. However, based on the Army Corps of Engineers and WDOE monitoring results, the Mid-Columbia River was placed on the 303(d) list for total dissolved gas, water temperature, pH, and a water column bioassay (WDOE 1998a). Sources of water quality impacts include agriculture run-off and irrigation return flows, depletion of instream flows from diversions, and impoundment and flow regulation of hydropower projects.

The Army Corps of Engineers measures temperature and total dissolved gas regularly at each dam (U.S. Army Corps of Engineers 1998). The Columbia River below Rock Island (Station 44A070) and near Chelan, Washington (Station 47B070), has been monitored by WDOE for temperature, conductivity, dissolved oxygen, total dissolved gas, pH, fecal coliforms, suspended solids, turbidity, ammonia, phosphorous, nitrate and nitrite, and hardness (BPA et al. 1995a; WDOE 1998b). Total and dissolved metals data from sampling in 1998 just upstream of Rock Island Dam was also included (Parametrix 1999).

In October 1999, Chelan County PUD began a program of water quality monitoring of Rocky Reach Reservoir between the Wells Dam tailrace and the Rocky Reach tailrace (Parametrix 1999). The primary purpose of the program is to provide information to support a Water Quality Certification for relicensing of the Rocky Reach project. The program will also provide information needed to define the relationships between water quality and beneficial uses, including fisheries, recreation, water supply, and aesthetics. Nutrients, chlorophyll *a*, phytoplankton, zooplankton, and attached benthic algae are being sampled seasonally to provide information on trophic conditions. Other conventional water quality analyses include water temperature, pH, dissolved oxygen, turbidity, and total suspended solids.

The temperature regime of the Mid-Columbia River is largely influenced by releases from Lake Roosevelt, the primary deepwater storage facility created by Grand Coulee Dam. Lake Roosevelt becomes thermally stratified during the summer, and the temperatures of surface water released at Grand Coulee Dam can be very warm (U.S. Army Corps of Engineers 1993). Conversely, water released at depth (through the turbines) is cold.

High water temperatures adversely effect salmonids by increasing the incidence of disease; altering the timing of adult and juvenile migrations; changing incubation, hatching, and maturation times; and affecting gas supersaturation (BPA et al. 1995a; Chapman et al. 1994a and 1995a; Dauble and Mueller 1993). High water temperatures can also be lethal to fish.

Water temperatures exceeding 19 to 21° C have also been shown to delay adult anadromous salmonid migration (Dauble and Mueller 1993). Spawning fish have limited energy reserves, and any delay in migration may reduce those reserves to the point where fish may not be able to spawn successfully (BPA et al. 1995a). High temperatures not only reduce energy reserves by blocking fish migration but also by increasing the fishes' metabolic rates.

High water temperatures can be lethal to salmon and steelhead after some exposure duration. When exposed to temperatures of 21° C or above for more than 7 days, 50 percent of adult salmon and steelhead populations experience mortality (Dauble and Mueller 1994).

Water temperatures at levels that may not directly kill anadromous salmonids may cause indirect stress-related mortality (Dauble and Mueller 1993). In addition, the rate of pre-spawning mortality can be increased by warm temperatures in combination with other stresses, such as disease through pathogenic agents and total dissolved gas.

The Mid-Columbia River hydroelectric projects are run-of-river facilities with very limited capacity for storage and flow regulation. The very rapid flushing rates in these reservoirs limit the potential warming that can occur. Water temperatures do not appear to be significantly warmed through the Mid-Columbia River projects (U.S. Army Corps of Engineers 1993).

Jaske (1967) concluded that dams and reservoirs on the Columbia River had only a nominal effect on the annual mean temperature of the entire system, and this effect was less than one degree C over the thirty-year period 1936 to 1966. He also found that the projects had delayed the occurrence of annual maximum peak temperatures in proportion to the increased travel time of water flowing through the system.

Suspended solids and turbidity in the Mid-Columbia River are relatively low (BPA et al. 1995a). The Grand Coulee project and downstream reservoirs slow the river flow and allow solids to settle. Turbidity and suspended solids in Mid-Columbia River tributaries are commonly higher compared to the mainstem (BPA et al. 1995a).

Wells Dam

Water temperature and total dissolved gas levels sometimes exceed State standards at Wells Dam (Table 3-5). The Columbia River was listed as water quality limited due to high total dissolved gas below Wells Dam and temperature exceedances at the inflow to the Wells Hatchery (WDOE 1998a).

Ambient monitoring data collected by WDOE downstream from Wells Dam near Chelan, Washington generally indicates good water quality (Table 3-6). Dissolved oxygen levels stayed above 8 milligrams per liter and pH remained within the standard range of 6.5 to 8.5. Fecal coliform organisms, suspended solids, phosphorous, turbidity, and nitrate levels were low (WDOE 1998b).

Rocky Reach Dam

Temperature and total dissolved gas measurements from below Rocky Reach Dam are summarized in Table 3-5. The mainstem of the Columbia below Rocky Reach Dam is in the same segment as the Rock Island Dam. This reach was listed as water quality limited due to temperature, total dissolved gas, and a water column bioassay, as described for Rock Island Dam (WDOE 1998a).

Except for the total dissolved gas and water temperature issues, water quality in the Columbia River at Rocky Reach Dam is generally good (see Table 3-6). Dissolved oxygen levels do not typically decline below 8.0 milligrams per liter, and turbidity and suspended sediments are relatively low since the dam slows the river and allows sediment to settle out. Ammonia levels are typically below the freshwater standard. Mean annual phosphate concentrations often exceed levels that could stimulate excessive algae growth, but rapid flushing in the Rocky Reach reservoir limits primary productivity there (NMFS et al. 1998c).

TABLE 3-5. SUMMARY OF DAILY TEMPERATURE AND TOTAL DISSOLVED GAS MONITORING RESULTS SUMMARY FOR MID-COLUMBIA RIVER DAMS

STATION		CHIEF JOSEPH DAM	WELLS DAM	ROCKY REACH DAM	ROCK ISLAND DAM
Water Years for Temperature[1]		**1981 to 1993**	**1981 to 1997**	**1981 to 1997**	**1981 to 1997**
Temperature (^{o}C)					
	Max	20.0	20.0	20.2	23.8
1998 Total Dissolved Gas[2] (%)					
Forebay	Avg	107.5	108.0	107.0	107.7
	Max	114.7	113.0	117.3	121.3
	Min	98.7	103.8	90.9	90.4
Tailrace	Avg	108.7	111.9	114.4	114.7
	Max	119.3	121.2	121.2	124.8
	Min	93.3	105.8	105.8	103.2

1 = Values are from Army Corps of Engineers 1998 (1994-1997 data for Chief Joseph Dam were not available at this site).
2 = Values are from Army Corps of Engineers 1999.

TABLE 3-6. WATER QUALITY DATA SUMMARY FOR THE MID-COLUMBIA RIVER

PARAMETERS	STAT	COLUMBIA RIVER NEAR ROCK ISLAND[1]	COLUMBIA RIVER AT ROCK ISLAND[2]	COLUMBIA RIVER NEAR CHELAN[3]	WA STATE STANDARDS[4]
Water Years		**Aug - Oct 1998**	**1975 to 1990**	**1993**	
Temperature	Avg	18.8	N/A	10.0	18^{o}C
(^{o}C)	Max	20.6	23	18.2	
	Min	15.6	0.8	1.5	
Conductivity	Avg	134	N/A	123	
(mmhos/25^{o}C)	Max	157	220	137	
	Min	119	95	111	
Dissolved Oxygen	Avg	8.96	N/A	11.1	>8 mg/L
(mg/L)	Max	9.53	16.3	13.5	
	Min	8.63	7.9	9.2	
Oxygen Saturation	Avg	N/A	N/A	98.6	110.0%
(%)	Max	N/A	N/A	109.2	
	Min	N/A	N/A	89.5	
pH	Avg	7.82	N/A	8.1	6.5 - 8.5
	Max	8.04	9.2	8.4	
	Min	7.62	6.8	7.6	
Fecal Coliforms	Avg	N/A	N/A	1	<100 col/100mL
(colonies/100ml)	Max	N/A	N/A	2	
	Min	N/A	N/A	1	

TABLE 3-6 WATER QUALITY DATA SUMMARY FOR THE MID-COLUMBIA RIVER (CONTINUED)

PARAMETERS	STAT	COLUMBIA RIVER NEAR ROCK ISLAND[1]	COLUMBIA RIVER AT ROCK ISLAND[2]	COLUMBIA RIVER NEAR CHELAN[3]	WA STATE STANDARDS[4]
Water Years		**Aug - Oct 1998**	**1975 to 1990**	**1993**	
Suspended Solids	Avg	2 u	N/A	2	
(mg/L)	Max	2	300	3	
	Min	2 u	0.1	1	
Ammonia Nitrogen	Avg	N/A	N/A	0.010	~0.25 mg N/L
(mg N/L)	Max	N/A	0.26	0.018	
	Min	N/A	0	0.010 u	
Total Phosphorus	Avg	N/A	N/A	0.012	~0.035 mg/L[5]
(mg/L)	Max	N/A	0.74	0.020	
Turbidity	Avg	N/A	N/A	0.7	
(NTU)	Max	N/A	11	1.4	
	Min	N/A	0.6	0.4	
Nitrate + Nitrite	Avg	N/A	N/A	0.1	~10 mg/L
(mg/L)	Max	N/A	0.43	0.3	
	Min	N/A	0	0.1	
Hardness	Avg	66	N/A	N/A	
(mg/L CaCO3)	Max	73	110	N/A	
	Min	62	49	N/A	
Total Metals (µg/L)					
Aluminum	Max	34.9	N/A	N/A	87
Cadmium	Max	0.13	N/A	N/A	0.78
Copper	Max	0.88	N/A	N/A	7.9
Mercury	Max	0.00068	N/A	N/A	0.012
Lead	Max	0.141	N/A	N/A	1.7
Zinc	Max	2.18	N/A	N/A	71
Dissolved Metals (µg/L)					
Aluminum	Max	4.63	N/A	N/A	N/A
Cadmium	Max	0.06	N/A	N/A	0.72
Copper	Max	0.69	N/A	N/A	7.5
Mercury	Max	0.00084	N/A	N/A	N/A
Lead	Max	0.053	N/A	N/A	1.5
Zinc	Max	2.45	N/A	N/A	70

1 = Values are from Parametrix 1999.
2 = Values are from BPA et al. 1995a.
3 = Values are from WDOE 1998b.
4 = Values are from Chapter 173-201A WAC.
5 = Mid-Columbia reservoirs have a retention time of less than 15 days and do not meet the classification of lake. Therefore, this value is an indication of potential eutrification rather than a standard.
~ = Values are approximate from USEPA 1986, 1998, and Chapter 173-201A WAC.
N/A = Not available/applicable
mg/L = milligrams per liter
µg/L = micrograms per liter
CaCO3 = calcium carbonate
^{o}C = degrees Celsius
mmhos/25^{o}C = milli-mhos
u = Not detected above the reported sample quantitation limit.

Preliminary results from recent Chelan County PUD studies indicate that phosphorus concentrations in the water column are well below the levels that promote phytoplankton blooms, but nutrients in nearshore, shallow areas are supporting relatively high levels of attached benthic algae (Parametrix 2000).

Excessive sediment loading to the Columbia River has occurred at the mouth of the Entiat River since much of the Entiat River watershed burned in the 1994 Tyee fire. This loading has created a delta at the mouth of the Entiat River because of increased flows from the Entiat River and decreased flows of the Columbia behind Rocky Reach Dam (Whitehall 1999, personal communication).

Rock Island Dam

The Army Corps of Engineers measures temperature and total dissolved gas data at Rock Island Dam (see Table 3-5). Temperatures in the Columbia sometimes exceed State standards set by WDOE (18ºC) with a maximum of 23.8ºC at Rock Island Dam (U.S. Army Corps of Engineers 1998). The Columbia River below Rock Island Dam was placed on the 303(d) list for temperature and total dissolved gas (WDOE 1998a).

The Columbia River upstream from Rock Island Dam near Wenatchee, Washington was placed on the State 303(d) list due to a water column bioassay (WDOE 1998a). However, outfall permit samples collected in this area for the ALCOA aluminum plant indicated that all total and dissolved metals concentrations were below Washington State standards (see Table 3-6) (Parametrix 1999). The source of toxic effects indicated by the bioassay is unknown.

Water quality in the Columbia River at Rock Island is generally good (see Table 3-6). Dissolved oxygen levels do not typically drop below the State Class A minimum standard of 8.0 milligrams per liter. Occasional dissolved oxygen concentrations below the standard may occur when hot weather coincides with irrigation withdrawals, low flows, and irrigation return flows containing high levels of nutrients and organic matter. Turbidity and suspended solids are usually low. The pH levels have exceeded the standard with a maximum of 9.2 at Rock Island, but yearly averages range from 6.7 to 8.1, within the standard 6.5 to 8.5 range (BPA et al. 1995a). Total phosphate concentrations at the dam (maximum of 0.74 milligrams per liter, BPA et al. 1995a) indicate enriched nutrient conditions that could promote excessive production of algae and other aquatic plants.

3.3.2.2 Associated Tributaries

The main tributaries flowing into the Mid-Columbia River are on the west side of the Columbia River: the Wenatchee, Entiat, Methow, and Okanogan rivers. There are smaller streams entering from the east, such as Foster Creek and Rock Island Creek. Land use on the east side is mostly non-irrigated agriculture, barren, or rangeland (USGS 1998). No water quality data were available for these creeks. However, these small creeks have very limited flows and therefore their contribution to the Columbia is considered negligible.

Wenatchee River

Water quality data were acquired at the WDOE ambient monitoring station near the mouth of the Wenatchee River and are summarized in Table 3-7. Water quality in the Wenatchee River is generally good; however, the river was placed on the 303(d) list for temperature, pH, and dissolved oxygen (WDOE 1998a). Sediment samples collected near the mouth of the Wenatchee River indicated that there were no toxic accumulations of organic or inorganic chemicals present (Hindes 1994).

Various tributaries of the Wenatchee River are on the 303(d) list, indicating impaired water quality conditions that limit beneficial uses of these streams (WDOE 1998a). Mission Creek, the tributary closest to the mouth of the Wenatchee River, is listed for temperature, fecal coliforms, DDT, and guthion (azinphos-methyl). Mission Creek was also

TABLE 3-7. WATER QUALITY DATA SUMMARY FOR MID-COLUMBIA RIVER TRIBUTARIES

STATION		WENATCHEE RIVER AT WENATCHEE	ENTIAT RIVER NEAR ENTIAT	METHOW RIVER NEAR PATEROS	OKANOGAN RIVER AT MALOTT	WA STATE STANDARDS[1]
Water Years		**1992 to 1997**	**1994 to 1997**	**1992 to 1997**	**1992 to 1997**	
Temperature	Avg	9.1	7.5	8.3	10.1	18^o C
(^{o} C)	Max	21.2	19.4	19.0	22.3	
	Min	0.0	0.0	0.0	0.0	
Conductivity	Avg	62	84	145	221	N/A
(mmhos/25^{o}C)	Max	107	152	300	396	
	Min	28	32	59	86	
Dissolved Oxygen	Avg	12.3	12.2	11.8	10.8	>8 mg/L
(mg/L)	Max	15.6	15.4	15.1	14.7	
	Min	9.4	9.1	9.2	7.7	
Oxygen Saturation	Avg	106.4	102.2	101.5	95.1	110.0%
(%)	Max	127.3	115.0	109.0	109.6	
	Min	84.6	96.1	96.5	85.0	
pH	Avg	7.7	8.0	8.0	8.1	6.5 - 8.5
	Max	9.4	9.0	8.7	8.5	
	Min	6.8	7.4	7.0	7.4	
Fecal Coliforms	Avg	16	11	8	25	<100 col/100mL
(colonies/100ml)	Max	130	72	150	96	
	Min	0.05	1 u	1 u	1	
Suspended Solids	Avg	11	13	7	21	N/A
(mg/L)	Max	116	198	122	153	
	Min	1	1 u	1 u	1 u	
Ammonia Nitrogen	Avg	0.009	0.008	0.008	0.009	~0.25 mg/L
(mg/L)	Max	0.018	0.022	0.019	0.023	
	Min	0.010 u	0.010 u	0.010 u	0.010 u	
Total Phosphorus	Avg	0.027	0.045	0.027	0.044	N/A
(mg/L)	Max	0.785	0.911	0.817	0.867	
	Min	0.010 u	0.010 u	0.010 u	0.010 u	
Turbidity	Avg	3.6	3.9	2.5	7.2	N/A
NTUs	Max	60.0	50.0	45.0	65.0	
	Min	0.3	0.4	0.3	0.8	

TABLE 3-7. WATER QUALITY DATA SUMMARY FOR MID-COLUMBIA RIVER TRIBUTARIES (CONTINUED)

STATION		WENATCHEE RIVER AT WENATCHEE	ENTIAT RIVER NEAR ENTIAT	METHOW RIVER NEAR PATEROS	OKANOGAN RIVER AT MALOTT	WA STATE STANDARDS[1]
Water Years		**1992 to 1997**	**1994 to 1997**	**1992 to 1997**	**1992 to 1997**	
Nitrate + Nitrite	Avg	0.2	0.2	0.2	0.1	~10 mg/L
(mg/L)	Max	0.4	0.4	0.4	0.1	
	Min	0.1	0.1	0.1	0.1	

1 = Values are from Chapter 173-201A WAC.
~ = Values are approximate from USEPA 1986, 1998, and Chapter 173-201A WAC.
u = Not detected above reported sample quantitation limit.
N/A = Data not available.

Source: WDOE 1998b.

listed for concentrations of 4,4'-DDT and 4,4'-DDE above standard levels in edible rainbow trout tissue. Low dissolved oxygen conditions have also been measured in Mission Creek (Hindes 1994). Additional information specific to Mission Creek is included in the draft Wenatchee River watershed Ranking Report Addendum (Wenatchee River Watershed Steering Committee/Technical Advisory Committee 1996).

Peshastin Creek, upstream of Mission, is 303(d) listed for temperature (WDOE 1998a). Substandard dissolved oxygen concentrations, and elevated turbidity and fecal coliform concentrations have also been measured in Peshastin Creek (Hindes 1994). Icicle Creek enters the Wenatchee River upstream of Peshastin Creek and is listed for dissolved oxygen and temperature. Upstream of Icicle Creek is Chiwaukum Creek, which is listed for temperature. Nason Creek enters where Wenatchee Lake drains into the Wenatchee River, and is listed for temperature. The Little Wenatchee River drains into Wenatchee Lake, and is also listed for temperature. Low dissolved oxygen conditions have also been measured on the Little Wenatchee River (Hindes 1994).

The Chiwawa and White rivers, the largest tributaries that drain the north end of the Wenatchee River watershed, were not included on the 303(d) list (WDOE 1998a). However, low dissolved oxygen concentrations have been measured on several occasions in both streams (Hindes 1994).

Other creeks in the Wenatchee River watershed are Brender Creek, a tributary of Mission Creek listed for fecal coliforms and dissolved oxygen; and Chumstick Creek, listed for dissolved oxygen, pH, and fecal coliforms (WDOE 1998a).

Other parameters in the Wenatchee River have levels below State standards. Although fecal coliform levels included a maximum of 130 colonies/100mL (WDOE 1998b), the geometric mean met water quality standards. Turbidity, suspended solids, nitrate and ammonia are usually low (WDOE 1998b). Total phosphorous levels are high at certain times (maximum of 0.79 milligrams per liter), and may stimulate algae growth (WDOE 1998b).

Based largely on water quality conditions, the Chelan County Conservation District led a diverse group of organizations, agencies, and individuals in a consensus ranking of subwatersheds within the Wenatchee River watershed (Hindes 1994). Mission Creek was assigned the number one ranking based on exceedances of water quality standards, concerns that elevated nutrients and bacteria may be causing water quality problems in the lower Wenatchee River, sandstone soils that are vulnerable to erosion following disturbance, the presence of viable anadromous fish runs, and other criteria.

Local landowners and residents have formed a watershed association and are working with the

Chelan County Conservation District on a Federal grant and other cleanup projects to improve water quality in the Mission Creek subwatershed (Wenatchee River Watershed Steering Committee 1998). Other subwatersheds were ranked in the following order: Chumstick Creek, White River, main stem Wenatchee River, Nason Creek, Peshastin Creek, Icicle Creek, the Chiwawa River, and the Little Wenatchee River. A watershed action plan and implementation schedule have been developed to promote water quality improvements throughout the Wenatchee River watershed from on-site sewage systems, agriculture, forestry, and stormwater (Wenatchee River Watershed Steering Committee 1998).

Entiat River

Entiat River water quality is generally good. The Entiat River was listed on the State 303(d) list in 1996 because temperature and pH levels that exceeded State standards for monitoring during 1985 through 1991. However, based on acceptable water temperatures and pH in more recent years, WDOE has removed the Entiat River from its most recent proposed list (WDOE 1998a). No tributaries of the Entiat River were listed as water quality limited.

Dissolved oxygen levels measured near the town of Entiat have a range of 9.1 to 15.4 milligrams per liter (WDOE 1998b), meeting the Washington State minimum standard of 8.0 milligrams per liter. Fecal coliform, suspended solids, ammonia, turbidity and nitrate levels are usually low. Total phosphorous can be high at times and may stimulate algal growth (WDOE 1998b).

Several large fires have occurred in the Entiat River basin since 1970, the most recent one in 1994. This has resulted in increased sediment loads in the Entiat River, with large deposits forming a delta at the Entiat River mouth and into the Columbia River. Immediately following the fire, the USFS implemented erosion and flood control measures. Monitoring now includes sediments and temperature. It is evident that more sediment is being transported, but water temperatures have not changed much since the fire of 1994 (Whitehall 1999, personal communication).

Methow River

Water quality data from WDOE's monitoring station near Pateros on the Methow River are summarized in Table 3-7. Water quality is generally good. The Methow River is listed for temperature upstream of the mouth at the inflow to the Winthrop National Fish Hatchery (WDOE 1998a). The Twisp River, a tributary of the Methow River, is also listed for temperature.

The upper Methow and Chewuch rivers are classified as AA (extraordinary), and the lower Methow and Twisp rivers meet the class A (excellent) standards. Discharges from Winthrop and Twisp municipal wastewater treatment systems have not been identified as factors affecting the water quality. Sediment loading is not considered a major problem even with the logging, grazing, land clearing, agricultural cropland, development and road building in the watershed (NMFS et al. 1998c).

Dissolved oxygen levels in the Methow River usually remain above the State minimum standard of 8 milligrams per liter, pH generally remains within the limits of 6.5 to 8.5, and fecal coliform counts are generally low. Suspended solids, ammonia, turbidity, and nitrate generally have low levels, while phosphorous concentrations may stimulate algal growth (WDOE 1998b).

Okanogan River

Water quality data collected by WDOE at the Malott sampling station on the Okanogan River is summarized in Table 3-7. Water quality in the river and tributaries appear to be water quality limited for several parameters. The Okanogan River is listed for dissolved oxygen, temperature, and fecal coliform organisms (WDOE 1998a). Water temperatures exceed standards partly because of natural phenomena (low gradient and solar radiation on the upstream lakes), as well as sedimentation and summer low flows due to Canadian water storage and irrigation (NMFS et al. 1998c). The Okanogan was also listed for 4,4'-DDE, 4,4'-DDD, PCB-1254, and PCB-1260 concentrations above standards in edible carp tissue during 1994 (WDOE 1998a). A study in 1977 by the Pacific Northwest River basins Commission identified that water quality problems have been attributed to return flows of irrigation water, livestock impacts on bank vegetation and stability, erosion from non-irrigated cropland, and forest harvest practices, such as road construction (NMFS et al. 1998c).

Several tributaries of the Okanogan River have also been listed as water quality limited (WDOE 1998a).

Tallant Creek and an unnamed creek at Okanogan river mile 28.4 were listed for DDT. The Similkameen River, a major tributary of the Okanogan near the Canadian border, is listed for temperature at the WDOE monitoring station (river mile 5.0) and at the inflow to the Similkameen Hatchery. Also listed is arsenic, likely due to tailings piles in British Columbia (WDOE 1998a). Osoyoos Lake, on the Canadian border, is listed for 4,4'-DDE and 4,4'-DDD concentrations above standards in an edible fish tissue sample collected in 1989. Ninemile Creek runs into Osoyoos Lake, and is listed for DDT (WDOE 1998a). Dissolved oxygen, temperature, and pH levels have exceeded State standards in Omak Creek, but this stream is not 303(d)-listed because it is on the Colville Indian Reservation and does not fall under the jurisdiction of the State (WDOE 1998a).

The Okanogan River at Malott has pH levels within the State standard range of 6.5 to 8.5, and ammonia and nitrate levels are low (WDOE 1998b). Suspended solids and turbidity seem to be elevated at the mouth of the river compared to what would be expected from the Similkameen River and Osoyoos Lake combined (NMFS et al. 1998c). Phosphorous concentrations can increase at times and may stimulate algal growth (WDOE 1998b).

3.3.2.3 Columbia River System

General descriptions of water quality data for the Columbia River indicate that dissolved oxygen, turbidity, suspended sediments, and pH levels are not a problem. Ammonia levels have exceeded criteria upstream of this reach at Grand Coulee Dam and downstream of this reach at Priest Rapids Dam (BPA et al. 1995a). Rock Island Dam ammonia levels were below criteria (BPA et al. 1995a), as were levels near Chelan (WDOE 1998b). In general, annual mean nitrate levels remain below criteria.

Phosphorus concentrations in Lake Roosevelt and the Mid-Columbia River have greatly declined since the 1980s (Rensel 1999). This change has been attributed to the 1995 termination of phosphorus discharges to the Columbia River from a Canadian fertilizer plant just north of the border. The nutrient decline has resulted in a shift from borderline nitrogen limitation of phytoplankton growth and mesotrophic (i.e., moderately enriched) conditions to strong phosphorus limitation and oligotrophy (i.e., nutrient poor, low productivity conditions) in Lake Roosevelt and the Mid-Columbia River. Further decline of nutrient levels in the mainstem river may result as large upstream reservoirs retain available nutrients.

There are a few apple-packing facilities located along the Mid-Columbia River. Most of these facilities only discharge non-contact cooling water. There are about 10 facilities discharging process water, which includes chlorine, and they are monitored according to WDOE permits. These facilities generally meet permit limits and are not considered to have a major impact on the water quality (Huber 1999, personal communication).

3.4 VEGETATION

Key Terms

Aquatic Macrophytes – Plants that occur entirely immersed within or under water.

Noxious Weeds – These weeds are non-native plants that have been introduced to Washington. Noxious weeds can be destructive and competitive with native plants, and difficult to control by cultural or chemical practices. These exotic species can reduce crop yields, replace native plant and animal habitat, affect land values and recreational opportunities, and infiltrate waterways.

Riparian Vegetation – Riparian zones are broadly defined as those non-aquatic areas contiguous with waterbodies (wetlands, lakes, streams, and rivers) that are influenced by, and which influence, that water body. Often riparian zones exhibit higher plant and animal diversity and productivity than surrounding uplands, and are particularly important to fish and wildlife in arid regions. Riparian vegetation may or may not be distinct from the adjacent upland vegetation.

Wetlands – Areas that are inundated by surface or groundwater frequently enough to support vegetation that requires saturated or seasonally saturated soil conditions for growth and reroduction. Wetlands generally include marshes, bogs, peatlands, and similar areas such as river overflows, mudflats, and natural ponds.

* *See Chapter 6 for a complete listing of all Key Terms.*

Vegetation influences the quality of salmonid feeding, resting, rearing, and migratory habitat through several mechanisms including water quantity, quality, and temperature, as well as foraging opportunities. Evapotranspiration and infiltration in a watershed, which directly affect the amount of water released to streams, is dependent on the type and extent of vegetation present. Vegetation can control the nature and quality of sediment entering streams by its ability to bind soils and sediments. Shoreline and riparian vegetation provide shading to streams, which directly influences stream temperatures and the resulting survival of many fish species. Litter fall, photosynthesis, and respiration also provide food sources for fish as described below under riparian vegetation (Spence et al. 1996).

Land use agricultural and industrial practices (such as forestry, grazing, and mining) can alter watershed processes by changing the amount and type of upland vegetation. These changes affect the quantity and routing of water, sediments, nutrients, and other dissolved materials delivered to streams (Spence et al. 1996). In addition, irrigation and application of chemical fertilizers and pesticides associated with these land uses can affect water quality.

Described below is the vegetation within the Columbia River system, classified in groups by upland, riparian/wetland, and aquatic plant communities. These sections are followed by a discussion of rare plants and noxious weeds. The latter sections include tables of rare plant and noxious weed species that potentially occur in the project area or associated tributaries.

3.4.1 UPLAND VEGETATION

3.4.1.1 Project Area

The botanical investigations that have been conducted directly in the project area of the dams (Caplow 1990) identified undeveloped areas of shrub-steppe vegetation. These investigations have been part of more recent license requirements to determine if rare and sensitive plant species may occur in the vicinity of the project area and whether project operations can affect these species (FERC 1975, 1989b). Vegetation sampling can also be a component of habitat surveys for determining adequacy of riparian and upland habitat for fish and wildlife resources. From these surveys, records indicate that the flora is dominated by big sagebrush, rabbitbrush (*Chrysothamnus* spp.), bitterbrush (*Purshia tridentata*), bluebunch wheatgrass, balsamroot (*Balsamorhiza sagitatta*), and numerous non-native weed species such as cheat (*Bromus tectorum*), bulbous bluegrass (*Poa bulbosa*), knapweeds (*Centaurea* spp.), Russian thistle (*Salsola kali*), and western tansy-mustard (*Descurainia pinnata*).

Human occupation and land use occurs throughout the project area, ranging from residential and commercial development to irrigated orchards (predominantly apple, pears, and cherries) and rangeland grazing. These land use practices typically result in the change from native plant communities to communities dominated by non-native plants. Human occupation or use has occurred on more than 75 percent of the project area.

3.4.1.2 Associated Tributaries

Because of their large watershed basins, the associated tributaries pass through a variety of vegetation zones, including, at lower elevations, the big sagebrush/bluebunch wheatgrass or shrub-steppe zone. Above this zone are: (1) the *Artemisia tripartita/Festuca idahoensis* (three-tip sagebrush/Idaho fescue zone) shrub-steppe zones; (2) forested low-montane zones dominated by ponderosa pine, Douglas-fir, and grand fir (*Abies grandis*); and (3) subalpine zones dominated by lodgepole pine (*Pinus contorta*), Engelmann spruce (*Picea engelmannii*), and subalpine fir (*Abies lasiocarpa*) (Franklin and Dyrness 1988). Alpine areas that are generally devoid of trees occur at the highest elevations in the watersheds of the associated tributaries.

3.4.1.3 Mid-Columbia River System

The Columbia River floodplain and the foothills of the Cascade mountains are primarily within the *Artemisia tridentata*/*Agropyron spicatum* (big sagebrush/bluebunch wheatgrass or shrub-steppe) vegetation zone, which is characteristic of the driest portions of the Columbia basin physiographic province (Daubenmire 1988; Franklin and Dyrness 1988). The Columbia River passes through four major plant communities within this vegetation zone, beginning near Richland, Washington, and proceeding north through the Mid-Columbia River projects: shrub-steppe (with sagebrush), shrub-steppe (without sagebrush), ponderosa pine (*Pinus ponderosa*), and stands of Douglas-fir (*Pseudotsuga menziesii*) and grand fir (*Abies grandis*).

3.4.2 Riparian and Wetland Vegetation

Riparian vegetation directly affects aquatic biota by contributing organic detritus (dead leaves and other plant material, and insects) to the associated water body. These organic inputs form the basis of the aquatic food web, which includes salmonid species. Most aquatic organisms (including invertebrates and fish) are indirectly dependent on inputs of terrestrial detritus to the stream for their food.

Riparian vegetation also moderates temperature gradients in narrow reaches of streams and rivers where forest and shrub vegetation can shade the water. Riparian vegetation can slow stream velocities, remove sediment, and transform chemical pollutants, while naturally armoring shorelines and contributing large woody debris. Without riparian vegetation, a stream's biological substrate can diminish. Riparian vegetation also provides non-aquatic wildlife habitat and effective buffers between water resources and neighboring agricultural and urban development.

Changes in riparian vegetation and the biotic processing of detritus, as well as other factors, determine the kinds and abundance of aquatic organisms living in streams, from headwaters to large rivers. Removal of riparian vegetation significantly affects stream organisms by: (1) decreasing food inputs; (2) increasing the potential for primary productivity in aquatic plants; (3) increasing summer water temperatures; (4)

changing water quality and quantity; and (5) decreasing terrestrial habitat for adult insects (Knight and Bottorff 1984).

Wetlands provide physical and biological functions in a watershed. Biological functions include food web support and habitat for fish and wildlife. Physical functions include stream baseflow support, flood storage and floodflow desynchronization, and nutrient and sediment retention.

Maps of important wetland and riparian habitats for wildlife have been developed by WDFW. Wetlands identified by the National Wetland Inventory are also included on these maps. Additional habitat inventory work has been conducted by Payne et al. (1975) and by the Washington Natural Heritage Program.

3.4.2.1 Project Area

Historically, riparian vegetation formed in dynamic equilibrium with the disturbance caused by seasonal flows and flood events of the Columbia River. This dynamic, successional regime characterizing the natural system changed when hydroelectric dams were placed in the Columbia River, where relatively stable pool elevations favor mature plant communities. Currently, riparian zones in the Columbia River system vary from sparse vegetation to relatively complex, mature shrub- and tree-dominated habitats. Many areas along the reservoirs have been converted to orchards or other agricultural or development uses. Portions of shoreline have also been rip-rapped to prevent erosion.

Development of riparian vegetation in the project area is restricted by the arid conditions, rip-rapped embankments, and agricultural development. At lower elevations in undeveloped areas, shrub and forest riparian zones are dominated by species such as white alder (*Alnus rhombifolia*), water birch (*Betula occidentalis*), black cottonwood (*Populus trichocarpa*), willows (*Salix* spp.), and quaking aspen (*Populus tremuloides*). Common shrub species include wood rose (*Rosa woodsii*), redtwig dogwood (*Cornus sericea*), and snowberry (*Symphoricarpos alba*). Common herbaceous species include stinging nettle (*Urtica dioica*) and reed canarygrass (*Phalaris arundinacea*).

Wetland habitat in the vicinity of the Rock Island Dam includes mostly emergent habitats dominated by cattail (*Typha latifolia*) and bulrush (*Scirpus* spp.) (FERC 1988). Small areas of shrub-dominated wetlands are predominately willows and Russian-olive (*Elaeagnus angustifolius*). Wetland habitat in the vicinity of the Rocky Reach Dam consists of small patches of emergent vegetation located in protected coves where sediment has accumulated. Palustrine emergent habitat accounted for 13.1 acres of wetland habitat, where 90 patches of such habitat averaged 0.2 acres (FERC 1996a). These areas are dominated by cattail and bulrush.

3.4.2.2 Associated Tributaries

Along associated tributaries, riparian zones vary from being barren of vegetation to supporting relatively complex shrub- and tree-dominated habitats. Many areas along associated tributaries have been converted to orchards or other agricultural or development uses. Portions of shoreline have also been rip-rapped to prevent erosion.

Because of their large basins, associated tributaries pass through a variety of naturally occurring vegetation zones. From lower to higher elevations, these zones include the *Artemisia tripartita/Festuca idahoensis* (three-tip sagebrush/Idaho fescue zone) shrub-steppe; forested low-montane zones dominated by ponderosa pine, Douglas-fir, and grand fir (*Abies grandis*); and subalpine zones dominated by lodgepole pine (*Pinus contorta*), Engelmann spruce (*Picea engelmannii*), and subalpine fir (*Abies lasiocarpa*) (Franklin and Dyrness 1988).

The character of their associated upland and riparian zones changes substantially as these tributaries pass from one zone to another. Along the deeply incised streams of the Cascade mountains and Okanogan Highlands, riparian vegetation is usually limited to streambanks, but is more extensive where level bottomlands or terraces exist.

Large areas of wetlands exist within the watersheds of the associated tributaries. For example, more than 4,300 acres of wetlands have been mapped on the National Wetland Inventory in the Entiat watershed (Entiat River Watershed Coordinated Resource Management Plan, Draft, May 1999) and more than 17,200 acres in the Wenatchee watershed (Wenatchee River Watershed Steering Committee 1996). Most of these are associated with the upper and mid-portions of the rivers. Vegetated wetland habitats include emergent, shrub, and forested wetland classes.

3.4.2.3 Mid-Columbia River System

Because most of the Mid-Columbia River system is impounded, wetland and riparian habitats are similar to those described for the project area (Section 3.4.2.1).

3.4.3 AQUATIC VEGETATION

Aquatic plant communities in river and reservoir systems are characterized as more or less distinct zones of vegetation that are influenced by a complex of environmental variables such as water depth, exposure, turbidity, salinity, soil characteristics, etc. (Swindale and Curtis 1957; Sculthorpe 1967; Cowardin et al. 1979). Aquatic bed habitats are those wetland and deepwater zones dominated by plants that grow principally on or below the surface of the water for most of the growing season in most years (Cowardin et al. 1979). Aquatic bed habitats include areas dominated by algae or aquatic mosses, as well as rooted or vascular plants. Such habitat provides escapement and rearing habitat for numerous fish species. The scope of the following discussion is limited to aquatic bed habitats dominated by vascular plants (aquatic macrophytes).

3.4.3.1 Project Area

Some information is available on aquatic vegetation in the project area reservoirs (Tabor et al. 1980). Vegetation mapping in and around the Rocky Reach reservoir (river miles 473.6 to 515.5) identified 979 acres of aquatic bed habitat. Approximately 470 acres of this was dominated at that time by Eurasian milfoil (*Myriophyllum spicatum*), a State-listed noxious weed (Ebasco Environmental 1990). Other species included waterweed and pondweeds (*Potamogeton* spp.). Between 1984 and 1991, the overall acreage of aquatic biomass in the Rocky Reach reservoir increased approximately 15 percent (FERC 1996a). Duckweed, sago pondweed, and waterweed have also been documented in aquatic bed communities at Wells reservoir (river mile 537.2) (Tabor et al. 1980).

3.4.3.2 Associated Tributaries

Little information is available on aquatic vegetation resources in the associated tributaries. It is likely that many of the same aquatic macrophytes found in reservoirs of the Columbia River also occur in suitable habitats in the associated tributaries.

3.4.3.3 Mid-Columbia River System

Prior to the construction of dams, aquatic bed habitats along the Columbia River system were predominantly limited to narrow zones along the shorelines and larger zones in backwater areas. Data collected by Tabor et al. (1980) from 23 sites along the Columbia River between Rooster Rock State Park (river mile 128.5) and Washburn Island (river mile 538) suggest that floating and submergent aquatic plants were reduced by pre-dam water level fluctuations. Historically, where water level fluctuation was reduced, plants with these growth forms occurred predominantly and had higher areal coverage.

Aquatic bed vegetation in the lower non-tidal reaches of the Columbia system (Interstate 5 to The Dalles, river miles 106 and 192, respectively) is typically restricted to embayments and other protected sites. These areas are dominated by native species such as duckweed (*Lemna minor*), waterweed (*Elodea canadensis*), sago or fennel-leaved pondweed (*Potamogeton pectinatus*), and the non-native curled pondweed (*Potamogeton crispus*) (Stanford Research Institute 1971; Tabor et al. 1980; Annear 1992, personal communication). No information is available on the areal extent of aquatic bed habitat in this part of the Columbia system.

At McNary reservoir (river mile 317), sago and curled pondweeds are the dominant species in aquatic bed communities (Tabor et al. 1980). In their investigation of the Hanford reach (river miles 345 to 396), a free-flowing reach of the Columbia River upstream of McNary Dam, Fickeisen et al. (1980) identified no aquatic bed vegetation. However, the native persistent-sepal or Columbia yellow cress (*Rorippa columbiae*) (a Federal species of concern and State-listed threatened species) grows submerged for most of the year in portions of the Hanford reach (Sackschewsky et al. 1992) and forms small patches of aquatic bed vegetation (Antieau 1992, personal observation).

3.4.4 Rare Plants

The project area and associated tributary watersheds provide habitat for numerous rare plant species (Table 3-8). Although there is only one species Federally listed as threatened in the vicinity of the project area, there is also one species that is proposed for listing, and eleven plants that are Federal species of concern. All of the species in Table 3-8 are listed as sensitive, threatened, or endangered by the State of Washington (USFWS 1998; Washington Natural Heritage Program 1997). The Federally listed species (Ute ladies' tresses; *Spiranthes diluvialis*) occurs in Okanogan County, while the Oregon checker-mallow (*Sidalcea oregana* var. *calva*) occurs in the Wenatchee River watershed. However, neither of these species occur in or near the immediate project area of the dams.

All of the species without Federal listing status included in Table 3-8 are known to occur in the watersheds of the associated tributaries and/or in areas close to the project areas (within 50 feet of the maximum pool elevation of the project reservoirs). Nine species have populations within 50 feet of the maximum pool elevation of some reservoirs in the project area (Caplow 1990). However, all but two of these nine species are upland-dwelling species and not associated with the wetted shorelines of these reservoirs. One exception, longsepal globemallow (*Illiamna longisepala*), occurs in riparian zones associated with tributaries to the Columbia River. Another exception, giant helleborine (*Epipactis gigantea*), is known to occur on or near the wetted shorelines of some project area reservoirs. The remaining species in Table 3-8 occupy a broad diversity of habitats ranging from low elevation to high elevation and wetland/riparian habitats to rock/cliff habitats.

3.4.5 Noxious Weeds

The State of Washington regulates the presence and spread of noxious weeds under authority of the Noxious Weed Control Act and its implementing code (RCW 17.10.007 and WAC 16-750). These species are of relevance because habitat improvement projects planned under any alternative should include plans to ensure that these plants do not spread, and are eradicated whenever encountered.

State-listed noxious weeds are classified into one of three categories. Class A weeds are non-native species with a limited distribution in Washington. Eradication of these species is mandatory in Washington. Class B weeds are non-native species that are presently limited in distribution in Washington and pose a serious threat to resources. Control of these weeds is mandatory in those counties in which these species occur.

Class-B Designate weed species are those species where control is mandatory. Control is defined as the prevention of all seed production in a single program year, with the eventual aim being a

TABLE 3-8. PROPOSED, THREATENED, ENDANGERED, AND SENSITIVE PLANT SPECIES FOUND IN THE PROJECT AREA OR IN WATERSHEDS OF THE ASSOCIATED TRIBUTARIES

SCIENTIFIC NAME	COMMON NAME	FEDERAL STATUS[1]	STATE STATUS[2]	OCCURRENCE[3]
Agoseris elata	Tall agoseris	-	S	AT
Agrostis borealis	Northern bentgrass	-	S	AT
Anemone nuttalliana	Pasqueflower	-	S	AT
Aster sibericus var. *meritus*	Arctic aster	-	S	AT
Astragalus arrectus	Palouse milk-vetch	-	S	AT, PA
Astragalus misellus var. *pauper*	Pauper milk-vetch	-	S	AT, PA
Astragalus sinuatus	Whited milk-vetch	FSC	E	AT
Botrychium ascendens	Triangular-lobed moonwort	FSC	S	AT
Botrychium crenulatum	Crenulate moonwort	FSC	S	AT
Botrychium lanceolatum	Lance-leaved grape fern	-	S	AT
Botrychium lunaria	Moonwort	-	S	AT
Botrychium paradoxum	Two-spiked moonwort	FSC	S	AT
Botrychium pinnatum	St. John moonwort	-	S	AT
Botrychium simplex	Little grape-fern	-	S	AT
Camissonia pygmaea	Dwarf evening-primrose	-	T	AT
Carex atrosquama	Blackened sedge	-	S	AT
Carex buxbaumii	Buxbaum sedge	-	S	AT
Carex capillaris	Hair-like sedge	-	S	AT
Carex chordorrhiza	Cordroot sedge	-	S	AT
Carex comosa	Bristly sedge	-	S	AT
Carex dioica	Yellow bog sedge	-	S	AT
Carex eleocharis	Narrow-leaved sedge	-	S	AT
Carex heterone	Different-nerved sedge	-	S	AT
Carex hystricina	Porcupine sedge	-	S	AT
Carex magellanica ssp. *irrigua*	Poor sedge	-	S	AT
Carex norvegica	Scandanavian sedge	-	S	AT
Carex proposita	Smoky mountain sedge	-	S	AT
Carex saxatilis var. *major*	Russett sedge	-	S	AT
Carex scirpoidea var. *scirpoidea*	Canadian single-spike sedge	-	S	AT
Carex sychnocephala	Many-headed sedge	-	S	AT
Carex tenuiflora	Sparse-leaved sedge	-	S	AT
Carex vallicola	Valley sedge	-	S	AT
Carex xerantica	White-scaled sedge	-	S	AT
Chaenactis thompsonii	Thompson chaenactis	-	S	AT
Chrysosplenium tetrandum	Northern golden-carpet	-	S	AT
Cicuta bulbifera	Bulb-bearing water hemlock	-	S	AT
Cryptantha spiculifera	Snake River cryptantha	-	S	AT

TABLE 3-8. PROPOSED, THREATENED, ENDANGERED, AND SENSITIVE PLANT SPECIES FOUND IN THE PROJECT AREA OR IN WATERSHEDS OF THE ASSOCIATED TRIBUTARIES (CONTINUED)

SCIENTIFIC NAME	COMMON NAME	FEDERAL STATUS[1]	STATE STATUS[2]	OCCURRENCE[3]
Cryptogramma stelleri	Steller rockbrake	-	S	AT
Cypripedium fasciculatum	Clustered lady-slipper orchid	FSC	T	AT
Cypripedium parviflorum	Yellow lady-slipper orchid	-	E	AT
Delphinium viridescens	Wenatchee larkspur	FSC	T	AT
Draba aurea	Golden draba	-	S	AT
Draba cana	Lance-leaved draba	-	S	AT
Eleocharis rostellata	Beaked spike-rush	-	S	
Elitrichium nanum var. *elongatum*	Pale alpine forget-me-not	-	S	AT
Epipactis gigantea	Giant helleborine	-	S	AT, PA
Erigeron salishii	Salish fleabane	-	S	AT
Eriophorum viridicarinatum	Green-keeled cotton-grass	-	S	AT
Gentiana glauca	Glaucous gentian	-	S	AT
Gentianella tenella	Slender gentian	-	S	AT
Geum rivale	Water avens	-	S	AT
Geum rossii var. *depressum*	Ross avens	-	S	AT
Githopsis specularioides	Common blue-cup	-	S	AT, PA
Hackelia hispida var. *disjuncta*	Sagebrush stickseed	-	S	AT, PA
Hackelia venusta	Showy stickseed	FSC	E	AT
Iliamna longisepala	Longsepal globemallow	-	S	AT, PA
Listera borealis	Northern twayblade	-	S	AT
Mimulus pulsiferae	Pulsifer monkeyflower	-	S	AT
Nicotiana attenuata	Coyote tobacco	-	S	AT, PA
Oxytropis campestris var. *gracilis*	Slender crazyweed	-	S	AT
Parnassia kotzebuei	Kotzebue grass-of-Parnassus	-	S	AT
Pellaea brachyptera	Sierra cliff-brake	-	S	AT
Pellaea breweri	Brewer cliff-brake	-	S	AT
Petrophyton cinerascens	Chelan rockmat	FSC	T	AT, PA
Phacelia lenta	Sticky phacelia	FSC	T	AT
Platanthera obtusta	Small northern bog orchid	-	S	AT
Polemonium viscosum	Skunk polemonium	-	S	AT
Potentilla diversifolia var. *perdissecta*	Diverse-leaved cinquefoil	-	S	AT
Potentilla nivea	Snow cinquefoil	-	S	AT
Potentilla quinquefolia	Five-leaved cinquefoil	-	S	AT
Rubus acaulis	Nagoonberry	-	S	AT
Salix glauca	Glaucous willow	-	S	AT
Salix tweedyi	Tweedy willow	-	S	AT
Salix vestita var. *erecta*	Rock willow	-	EX	AT

TABLE 3-8. PROPOSED, THREATENED, ENDANGERED, AND SENSITIVE PLANT SPECIES FOUND IN THE PROJECT AREA OR IN WATERSHEDS OF THE ASSOCIATED TRIBUTARIES (CONTINUED)

SCIENTIFIC NAME	COMMON NAME	FEDERAL STATUS[1]	STATE STATUS[2]	OCCURRENCE[3]
Sanicula marilandica	Black snake-root	-	S	AT
Saxifraga cernua	Nodding saxifrage	-	S	AT
Saxifraga rivularis	Pygmy saxifrage	-	S	AT
Saxifragopsis fragarioides	Strawberry-saxifrage	-	S	AT
Sidalcea oregana var. *calva.*	Oregon checker-mallow	PE	E	AT
Silene seelyi	Seely silene	FSC	T	AT
Sisyrinchium septentrionale	Blue-eyed grass	-	S	AT
Spiranthes diluvialis	Ute ladies'-tresses	FT	T	AT
Spiranthes porrifolia	Western ladies'-tresses	-	S	AT
Talinum sediforme	Okanogan fameflower	-	S	AT
Teucrium canadense ssp. *viscidum*	woodsage	-	S	AT
Trifolium thompsonii	Thompson clover	FSC	T	AT, PA
Trimorpha elata	Tall bitter-fleabane	-	S	AT
Utricularia minor	Lesser bladderwort	-	S	AT
Vaccinium myrtilloides	Velvet-leaf blueberry	-	S	AT

[1] FSC = Federal Species of Concern, FT = Federal Threatened, PE = Proposed Endangered
[2] S = State-listed Sensitive, T = State-listed Threatened, E = State-listed Endangered, EX =Potentially Extirpated from Washington
[3] PA = Project Area (within 15 meters of maximum pool elevation), AT = Associated Tributaries

Source : Washington Natural Heritage Program.

reduction of the total acreage of infestation to a point where eradication is possible. Class C weeds are noxious weeds that are common throughout most of Washington. Infestations of Class-B Non-designate and Class C weeds are typically so expansive that weed control or the prevention of seed production is not feasible. Some Class C weeds are selected by the various County Weed Boards as priority weeds in their counties, where control becomes mandatory for those selected species. Weeds designated as "Additional" by some counties are those designated by the county noxious weed control board as requiring control in that county.

New invader weeds are those species not yet formally recognized by the State Noxious Weed Board as Class A weeds, but which are present in a county and posing a serious threat. For purposes of this analysis, only Class A, B-Designate, Additional, and New Invader weeds are included.

Numerous species of State-listed noxious weeds are found within the vicinity of the project area and in the watersheds of associated tributaries (Table 3-9). Generally, Class B weeds are more abundant and broadly distributed than the other classified noxious weeds. Knapweeds and starthistles (*Centaurea* spp.), kochia (*Kochia scoparia*), and hawkweeds (*Hieracium* spp.) are frequently present in upland areas surrounding each of the projects, in the watersheds of the associated tributaries, and in the Mid-Columbia River system. Parrotfeather (*Myriophyllum aquaticum*), and Eurasian water milfoil (*Myriophyllum spicatum*), fanwort (*Cabomba caroliniana*), and purple loosestrife are found in reservoirs and associated wetland habitats of the project area and associated tributaries.

TABLE 3-9. STATE-LISTED NOXIOUS WEEDS FOUND IN CHELAN, DOUGLAS, AND OKANOGAN COUNTIES

SCIENTIFIC NAME	COMMON NAME	CLASS[1]	OCCURRENCE[2]
Abutilon theophrasti	Velvet-leaf	A	CH, DG, OK
Carduus pycnocephalus	Italian-thistle	A	CH, DG, OK
Carduus tenuiflorus	Slenderflower-thistle	A	CH, DG, OK
Centaurea calcitrapa	Purple starthistle	A	CH, DG, OK
Centaurea macrocephala	Bighead knapweed	A	CH, DG, OK
Centaurea nigrescens	Vochin knapweed	A	CH, DG, OK
Crupina vulgaris	Common crupina	A	CH, DG, OK
Euphorbia oblongata	Eggleaf spurge	A	CH, DG, OK
Helianthus ciliars	Texas blueweed	A	CH, DG, OK
Heracleum mantegazzianum	Giant hogweed	A	CH, DG, OK
Hieracium floribundum	Yellow devil hawkweed	A	CH, DG, OK
Hydrilla verticillata	Hydrilla	A	CH, DG, OK
Isatis tinctoria	Dyers woad	A	CH, DG, OK
Mirabilis nyctaginea	Wild four-o-clock	A	CH, DG, OK
Peganum harmla	Peganum	A	CH, DG, OK
Salvia aethiopis	Mediterranean sage	A	CH, DG, OK
Salvia pratensis	Meadow clary	A	CH, DG, OK
Salvia scalrea	Clary sage	A	CH, DG, OK
Silybium marianum	Milk-thistle	A	CH, DG, OK
Solanum elaeagnifolium	Silverleaf nightshade	A	CH, DG, OK
Solanum rostratum	Buffalo-bur	A	CH, DG, OK
Soliva sessilis	Lawnweed	A	CH, DG, OK
Sorghum halepense	Johnson grass	A	CH, DG, OK
Spartina patens	Salt-meadow cordgrass	A	CH, DG, OK
Spartium junceum	Spanish broom	A	CH, DG, OK
Tamarix ramosissima	Saltcedar	A	CH, DG, OK
Thymelaea passerina	Spurge-flax	A	CH, DG, OK
Zygophyllum fabago	Syrian bean-caper	A	CH, DG, OK
Centaurea diffusa	Diffuse knapweed	Additional	CH
Centaurea repens	Russian knapweed	Additional	CH
Cirsium arvense	Canada thistle	Additional	CH
Kochia scoparia	Kochia	Additional	CH
Linaria vulgaris	Linaria vulgaris	Additional	CH
Tribulus terrestris	Puncture vine	Additional	CH
Alhagi maurorum	Camelthorn	B-Designate	CH, DG
Alopecurus myosuroides	Black grass	B-Designate	CH, DG
Amorpha fruticosa	Indigo bush	B-Designate	CH, DG
Anchusa arvensis	Annual bugloss	B-Designate	CH, DG
Anchusa officinalis	Common bugloss	B-Designate	CH, DG
Anthriscus sylvestris	Wild chervil	B-Designate	CH, DG
Bryonia alba	White byrony	B-Designate	CH, DG
Cabomba caroliniana	Fanwort	B-Designate	CH, DG
Carduus acanthoides	Plumeless-thistle	B-Designate	CH, DG, OK
Carduus nutans	Musk thistle	B-Designate	CH, DG, OK
Cenchrus longispinus	Longspine sandbur	B-Designate	CH, DG
Centaurea biebersteinii	Spotted knapweed	B-Designate	CH, DG
Centaurea diffusa	Diffuse knapweed	B-Designate	OK
Centaurea jacea	Brown knapweed	B-Designate	CH, DG
Centaurea jacea x nigra	Meadow knapweed	B-Designate	CH, DG
Centaurea maculata	Spotted knapweed	B-Designate	CH
Centaurea nigra	Black knapweed	B-Designate	CH, DG
Centaurea solstitialis	Yellow star-thistle	B-Designate	CH, DG, OK

TABLE 3-9. STATE-LISTED NOXIOUS WEEDS FOUND IN CHELAN, DOUGLAS, AND OKANOGAN COUNTIES (CONTINUED)

SCIENTIFIC NAME	COMMON NAME	CLASS[1]	OCCURRENCE[2]
Chaenorrhinum minus	Dwarf snapdragon	B-Designate	CH, DG
Chondrilla juncea	Rush skeletonweed	B-Designate	CH, DG
Cyperus esculentus	Yellow nutsedge	B-Designate	CH, DG
Cytisus scoparius	Scot broom	B-Designate	CH, DG, OK
Daucus carota	Wild carrot	B-Designate	CH, DG
Echium vulgare	blueweed	B-Designate	CH, DG
Egeria densa	Brazilian elodea	B-Designate	CH, DG
Eruca vesicaria ssp. *sativa*	Garden rocket	B-Designate	CH, DG
Euphorbia esula	Leafy spurge	B-Designate	CH, DG, OK
Geranium robertianum	Herb-robert	B-Designate	CH, DG
Hieracium atratum	Polar hawkweed	B-Designate	CH, DG
Hieracium auranticum	Orange hawkweed	B-Designate	CH, DG
Hieracium caespitosum	Yellow hawkweed	B-Designate	CH, DG
Hieracium laevigatum	Smooth hawkweed	B-Designate	CH, DG
Hieracium pilosella	Mouse-ear hawkweed	B-Designate	CH, DG
Hypochaeris radicata	Spotted cats-ear	B-Designate	CH, DG
Impatiens glandulifera	Policeman’s helmet	B-Designate	CH, DG
Lepidium latifolium	Perennial pepperweed	B-Designate	CH, DG
Lepyrodiclis holosteoides	Lepryodiclils	B-Designate	CH, DG
Leucanthemum vulgare	Ox-eye daisy	B-Designate	CH, DG
Linaria dalmatica	Dalmatian toadflax	B-Designate	CH, DG, OK
Lysimachia vulgaris	Garden loosestrife	B-Designate	CH, DG
Lythrum salicaria	Purple loosestrife	B-Designate	CH, DG, OK
Lythrum virgatum	Wand loosestrife	B-Designate	CH, DG
Myriophyllum aquaticum	Parrotfeather	B-Designate	CH, DG
Myriophyllum spicatum	Eurasian water milfoil	B-Designate	CH
Onopordum acanthinum	Scot thistle	B-Designate	CH, DG, OK
Picris hieraciodes	Hawkweed ox-tongue	B-Designate	CH, DG
Potentilla recta	Sulfur cinquefoil	B-Designate	CH, DG
Rorippa austriaca	Austrian field cress	B-Designate	CH, DG
Senecio jacobaea	Tansy ragwort	B-Designate	CH, DG
Shaerophysa salsula	Swainson-pea	B-Designate	CH, DG
Sonchus arvensis	Perennial sow thistle	B-Designate	CH, DG
Spartina alterniflora	Smooth cordgrass	B-Designate	CH, DG
Spartina anglica	Common cordgrass	B-Designate	CH, DG
Torillis arvensis	hedgeparsley	B-Designate	CH, DG
Ulex europaues	gorse	B-Designate	CH, DG
Anchusa officinalis	Common bugloss	New Invader	OK
Cardaria draba	White-top	New Invader	OK
Hieracium auranticum	Orange hawkweed	New Invader	OK
Hieracium caespitosum	Yellow hawkweed	New Invader	OK
Linaria vulgaris	Linaria vulgaris	New Invader	OK
Polygonum cuspidatum	Japanese knotweed	New Invader	OK
Senecio jacobaea	Tansy ragwort	New Invader	OK

[1] A = State recommends mandatory eradication, B = State reccommends mandatory control, Additional = Requires control by specific counties, New Invader = Not yet formally recognized as weeds, but considered a serious threat

[2] CH = Chelan County, DG = Douglas County, OK = Okanogan County

Source: State Noxious Weed Board.

3.5 WILDLIFE

Key Terms

Candidate Species – As defined by the NMFS – candidate species are wildlife, fish, and/or plants being considered for listing as endangered or threatened, but for which more information is needed before they can be proposed for listing.

Endangered Species – A species of plant, fish, or wildlife which is in danger of extinction throughout all or a significant portion of its range.

Habitat Improvement – Management of wildlife or fish habitat to increase its capability for supporting wildlife or fish.

Listed Species – Wildlife, fish, and/or plants that are identified as either threatened or endangered within a region, state, or nation. Federally-listed species are listed by the USFWS or NMFS and consequently receive statutory protection throughout areas where their populations are in decline under the Endangered Species Act.

Mitigation – Measures designed to counteract environmental impacts or make impacts less severe. These measures may include amending an impact by not taking a certain action or part of an action; minimizing an impact by repairing, rehabilitating, or restoring the affected environment; reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; or compensating for the impact by replacing or providing substitute resources or environment.

Monitoring – HCP monitoring consists of two types: (1) compliance monitoring where NMFS monitors the permittee's implementation of the requirements of the HCP, incidental take permit terms and conditions and implementation agreement, if applicable; and (2) effects and effectiveness monitoring where the permitee (or other designated entity) examines the impacts of the authorized incidental take (effects) and implementation of the operating conservation program to determine if the actions are producing the desired results (effectiveness).

Old-Growth Forest – A forest stand characterized by trees well past the age of maturity (dominant trees exceed 200 years of age). Stands exhibit declining growth rates and signs of decadence such as dead and dying treees, snags, and downed woody material.

** See Chapter 6 for a complete listing of all Key Terms.*

This section describes the wildlife-related licensing requirements and aquatic and shoreline wildlife species that are present in the project area, the tributaries, and in the Columbia River system. Wildlife conservation measures currently being conducted by the Chelan and Douglas County PUDs are described followed by threatened, endangered, and sensitive wildlife species that may occur in the vicinity of the project area and tributaries.

3.5.1 WILDLIFE-RELATED LICENSE REQUIREMENTS

Existing licenses for the Wells, Rocky Reach, and Rock Island projects include the provision that FERC may require modifications to dam features and operations and/or require certain new facilities for the purpose of conserving wildlife resources (Article 31, FERC 1957a; Article 41, FERC 1962a; Article 15, FERC 1975a). Additional license requirements that are specific to individual projects are described below. For Wells, the Douglas County PUD must (1) provide funds for wildlife research and mitigation projects related to project operations (Article 41, FERC 1975b); and (2) in cooperation with WDFW, produce an annual progress report on the wildlife mitigation program (Article 41, FERC 1975b). For Rocky Reach, Chelan County PUD must provide funds for wildlife research and mitigation projects related to project operations (Article 32, FERC 1957a). For Rock Island, Chelan County PUD must conduct mitigation and monitoring activities, as deemed necessary, for bald eagles, Canada geese, and wood ducks (Articles 404-407, FERC 1989b).

3.5.2 AQUATIC WILDLIFE

3.5.2.1 Project Area

The project area provides habitat for a variety of waterfowl and aquatic furbearers. Waterfowl use of the reservoirs is mostly for wintering habitat. Up to 17,000 ducks and geese have been observed overwintering on Rocky Reach reservoir, and 2,000 to 5,000 ducks and geese were observed overwintering on Rock Island reservoir (BPA et al. 1995b, River System Operation Review, Appendix N). Numbers of wintering ducks and geese at Wells reservoir are unknown. Common winter residents, by relative abundance, are American coots (*Fulica americana*), American wigeons (*Anas americana*), Canada geese (*Branta canadensis*), greater/lesser scaup (*Aytha* spp.), mallards (*Anas platyrhynchos*), and ring-necked ducks (*Aythya collaris*).

Other wintering waterfowl include gadwalls (*Anas strepera*), northern shovelers (*Anas clypeata*), buffleheads (*Bucephala albeola*), Barrow's goldeneyes (*Bucephala islandica*), ruddy ducks (*Oxyura jamaicensis*), common mergansers (*Mergus merganser*), and teal (*Anas* spp.). Common loons, pied-billed grebes (*Podilymbus podiceps*), eared grebes (*Podiceps nigricollis*), and western/Clark's grebe (*Aechmophorus occidentalis*) have been noted using the reservoirs.

Breeding waterfowl are mostly Canada geese, mallards, and common mergansers (*Mergus merganser*). Each year about 95 Canada geese pairs nest on Rock Island reservoir, 57 geese nest on Rocky Reach reservoir, and 84 geese nest on Wells reservoir (Fielder 1997; Hallet 1994, 1995, 1996, 1997). Nest sites are on islands and in goose nesting structures maintained by Chelan County PUD and WDFW. An unknown number of mallards and common mergansers also nest on islands and backwater areas along the reservoirs. Wildlife management areas, established as mitigation for hydroelectric project operation, as well as shoreline orchards and residential lawns, provide waterfowl brooding and grazing areas.

Other breeding waterfowl in the project area include wood ducks (*Aix sponsa*), which nest in natural and artificial nesting structures along Rock Island and Wells reservoirs. The Chelan County PUD maintains 92 wood duck nesting structures along the Rock Island reservoir and WDFW maintains about 100 wood duck boxes along the Wells reservoir. Wood duck nest boxes are not present along the Rocky Reach reservoir, and wood ducks are not known to nest in this area. Nesting habitat for cinnamon teal (*Anas cyanoptera*), green-winged teal (*Anas crecca*), gadwalls, pied-billed grebes, and coots is provided in reservoir backwater areas, although specific information on breeding occurrence is lacking for these species.

Aquatic furbearers present in the project area include beavers (*Castor canadensis*), muskrats (*Ondatra zibethicus*), and mink (*Mustela vison*). River otters (*Lutra canadensis*) are also present, but less common. Riparian vegetation, especially cottonwoods, willows, and emergent vegetation in backwater areas, provides important habitat for these species.

3.5.2.2 Associated Tributaries and Columbia River System

The lower reaches of the Wenatchee, Entiat, Methow, Okanogan, and Chelan rivers, as well as the Columbia River system contain habitat similar to that of the project area (the Mid-Columbia River from the tailrace of Rock Island Dam to the tailrace of Chief Joseph Dam). Species expected to be present in these areas are the same as for the project area.

3.5.3 SHORELINE WILDLIFE

3.5.3.1 Project Area

Much of the shoreline adjacent to the reservoirs has been developed for fruit orchards. Wetland and riparian vegetation is limited and in some cases is artificially developed and maintained as a mitigation and licensing requirement for previous Federal and public utility actions. Shoreline areas and islands that provide dense riparian vegetation and protected areas for wildlife include Turtle Rock Island, Earthquake Point and Daroga State Park at Rocky Reach reservoir, Cassimer Bar wetland at Wells reservoir, and the riparian areas at the tailrace of the Wells Dam.

Wildlife species that use shoreline habitats include terrestrial mammals, birds, amphibians, and reptiles. Mule deer (*Odocoileus virginianus*) inhabit range adjacent to each of the three reservoirs, and bighorn sheep (*Ovis canadensis*) are present near the Rocky Reach reservoir. The WDFW manages a big game winter area adjacent to the west shore of the downstream half of Rocky Reach reservoir. A deer fence, State Highway 97, and a railroad separate the winter range from the reservoir shoreline area, thus the project area is not an important component of the habitat base of big game herds.

Other terrestrial mammals that use shoreline areas include a variety of bat species, small mammals, badgers (*Taxidea taxus*), striped skunks (*Mephitis mephitis*), and coyotes (*Canis latrans*). Shrub-steppe shorelines provide habitat for Great Basin pocket mice (*Perognathus parvus*), deer mouse (*Peromyscus maniculatus*), and western harvest mice (*Reithrodontomys megalotis*), while talus slopes are used by yellow-bellied marmots (*Marmota flaviventris*), bushy-tailed woodrats (*Neotoma cinerea*), and Nuttall's cottontails (*Sylvilagus nuttalli*). Riparian cottonwood, Ponderosa pine, and willow areas provide forage and cover for a variety of species.

Shorebirds found along the reservoirs include killdeer (*Charadrius vociferus*), spotted sandpipers (*Actitis macularia*), terns (*Sterna* spp.), herons, and gulls. Soras (*Porzana carolina*), and possibly Virginia rails (*Rallus limicola*), may nest in the emergent vegetation of the backwater areas, although this has not been confirmed. Upland game birds that use the project area shorelines are ring-necked pheasants (*Phasianus colchicus*), California quail (*Lagopus californicus*), chukars (*Alectoris chukar*), and mourning doves (*Zenaidura macroura*). Raptors that commonly nest in the vicinity of the reservoirs include red-tailed hawks (*Buteo jamaicensis*), American kestrels (*Falco sparverius*), ravens (*Corvus corax*), great horned owls (*Bubo virginianus*), osprey (*Pandion haliaetus*), bald eagle (*Haliaeetus leucocephalus*), and western screech-owls (*Otus kennicottii*). Cliffs and large cottonwoods and Ponderosa pines provide raptor nesting sites. Artificial nesting platforms established by Chelan County PUD also are used by some species, and nest boxes maintained by the Chelan County PUD and WDFW are used by kestrels.

Songbirds that use shoreline areas include the yellow warbler (*Dendroica petechia*), song sparrow (*Melospiza melodia*), marsh wren (*Cistothorus palustris*), cedar waxwing (*Bombycilla cedrorum*), Nashville warbler (*Vermivora ruficapilla*), MacGillivray's warbler (*Oporornis tolmiei*), solitary vireo (*Vireo solitarius*), warbling vireo (*Vireo gilvus*), Bullock's oriole (*Icterus bullockii*), Lazuli bunting (*Passerina amoena*), and western tanager (*Piranga ludoviciana*). Belted kingfishers (*Ceryle alcyon*) use willows and cottonwoods as hunting perches. The large cottonwoods and ponderosa pine provide perch and nest sites for raptors and woodpeckers. Riparian and wetland vegetation provide nest, forage, and cover habitat for songbirds. Fruit orchards are used by a variety of birds, especially mourning doves (*Zenaida macroura*).

Amphibians likely to be present in wetland areas include Pacific treefrogs (*Hyla regilla*), tiger salamanders (*Ambystoma tigrinum*), long-toed salamanders (*Ambystoma macrodactylum*), Columbia spotted frog (*Rana luteiventris*), western toads (*Bufo boreas*), Great Basin spadefoots (*Scaphiopus intermontanus*), and bullfrogs (*Rana catesbiana*). Shallow backwater areas provide habitat for these species, except for the Great Basin spadefoot, which breeds in temporary pools and lays eggs buried underground for most of the year (Leonard et al. 1993).

Reptiles present in project area include painted turtles (*Chrysemys picta*), western rattlesnakes (*Crotalus viridis*), gopher snakes (*Pituophis catenifer*), western fence lizards (*Sceloporus occidentalis*), western skinks (*Eumeces skiltonianus*), rubber boas (*Charina bottae*), and western terrestrial and common garter snakes (*Thamnophis* spp.). Some of these species are closely associated with wetlands (i.e., painted turtles) while others are more common along rocky and talus shorelines (i.e., rubber boas).

3.5.3.2 Associated Tributaries

In the upper reaches of the Wenatchee, Entiat, Methow, and Okanogan rivers, and in the tributaries of these rivers, faster flowing, small streams bordered by riparian forest are present. These upper reaches provide habitat for a variety of riparian forest and stream associated wildlife, such as American dippers (*Cinclus mexicanus*), Steller's jays (*Cyanocitta stelleri*), ruby-crowned kinglets (*Regulus calendula*), and tailed frogs (*Ascaphus truei*). The tributaries of the Wenatchee, Entiat, Methow, and Okanogan rivers extend into remote areas where species such as bobcats (*Lynx rufus*) and mountain lions (*Felis concolor*) are expected to be more common than in developed areas.

3.5.3.3 Columbia River System

The Columbia River system is a vast area that includes approximately 1,200 river miles and a wide variety of associated habitats, including estuarine areas, riparian coniferous forests, riparian hardwood forests, wetlands, rocky cliffs, and shrub-steppe habitats. Wildlife present in this large, complex system include many of the wildlife species that occur in the Pacific Northwest. Species include marine mammals; estuarine shorebirds; riparian-forest associated birds and mammals; and shrub-steppe and cliff-associated wildlife such as northern sagebrush lizards (*Sceloporus graciosus graciosus*), bighorn sheep (*Ovis canadensis*), and golden eagles (*Aquila chrysaetos*). More detailed information on wildlife present in the Columbia River System is available in Appendix N of the Columbia River System Operation Review (BPA et al. 1995b).

3.5.4 WILDLIFE AND HABITAT ENHANCEMENT AND MONITORING

Chelan County PUD conducts a variety of wildlife and habitat enhancement and monitoring projects on the Rock Island and Rocky Reach reservoirs (Table 3-10). These include installing and maintaining goose nesting structures and wood duck nest boxes; conducting waterfowl, goose, and eagle surveys; and protecting riparian habitat. Some of these activities are required as part of licensing and settlement agreements, while others are voluntary. Habitat enhancement and monitoring projects on the Wells reservoir are conducted by WDFW, as part of a 1974 Settlement Agreement between Douglas County PUD and WDFW.

3.5.5 THREATENED AND ENDANGERED SPECIES

This section describes Federally- and State-listed threatened, endangered, and sensitive wildlife species in the project area and associated tributaries. State priority habitats are also discussed. In addition, a brief description of Federally- and State-listed threatened or endangered species in the Columbia River system is provided.

3.5.5.1 Project Area and Associated Tributaries

Federally-Listed Species

Only one Federally-listed threatened species, the bald eagle, is known to occur in the project area (WDFW 1999). Northern spotted owls, gray wolves, and grizzly bears all occur in the nearby Wenatchee National Forest, Okanogan National Forest, and Colville Indian Reservation, but there are no records for these species in the aquatic and riparian habitats of the project area (WDFW 1999).

Five Federally-listed threatened or endangered species are known to occur in the riparian and

Table 3-10. Recent and Ongoing Habitat Mitigation and Enhancement Projects in the Project Area

Project	License Requirement
Rock Island	
Erect and maintain 26 artificial goose nesting structures	10 required
Conduct goose nesting surveys (4-5 per year)	no[1]
Erect and maintain 92 wood duck nest boxes	60 required
Erect 4 raptor perch sites	no[1]
Conduct winter bald eagle surveys and monitor effect of recreation on bald eagles	no[1]
Wrap mature riparian trees for protection from beavers	no[1]
Conduct controlled burn to suppress noxious weeds and improve goose nesting and brooding areas on islands	no[1]
Fence a riparian corridor on Rock Island Creek to protect habitat from cattle overgrazing	no[1]
Rocky Reach	
Erect and maintain 23 artificial goose nesting structures	no[1]
Conduct goose nesting surveys (4-5 per year)	no[1]
Erect 2 raptor perch sites	no[1]
Conduct winter bald eagle surveys	no[1]
Wrap mature riparian trees for protection from beavers	no[1]
Contract botanist to conduct rare and sensitive plant survey	no[1]
Wells	
In 1974, the Wells PUD gave WDFW over 2,024 hectares of land and provided funding to manage the area for wildlife. The Wells PUD also voluntarily provides supplemental annual funding, and has since 1995	yes
Erect raptor pools (1984 pool raise agreement)	yes
Dike sloughs at Cassimer Bar to control/minimize water level fluctuations	yes

[1] Although this specific activity was not required as part of Chelan County PUDs' licensing requirements, the license does require the PUD to conduct wildlife mitigation activities.

aquatic habitats of the project area tributaries (Wenatchee, Entiat, Methow, and Okanogan rivers, and their associated tributaries) (Table 3-11). These species include the bald eagle (threatened), northern spotted owl (threatened), gray wolf (endangered), and grizzly bear (threatened).

Bald Eagle

Bald eagles generally occur along shores of saltwater and freshwater lakes and rivers that support substantial prey densities (generally anadromous fish or waterfowl) (Livingston et al. 1990; Stalmaster 1987). Breeding bald eagles use large trees for nesting that are generally within a mile of water and have an unobstructed view of water (ODFW 1996; Anthony and Isaacs 1989). Nest trees are usually within old-growth or residual old-growth stands, but some nesting also occurs in riverine forests dominated by cottonwood (*Populus* spp.) (ODFW 1996). Both breeding and wintering bald eagles forage over open water and use riparian trees for perching.

Two nesting bald eagle sites are known to occur in the vicinity of the project area. Since 1995, a nest site near Rocky Reach reservoir has been active each year (Fielder 1999 personal communication) and a nest site near Wells Dam has been intermittently active (Stoefel 1999 personal communication). Nesting eagles in the project area prey primarily on waterfowl. Wintering bald eagles are more common than nesting eagles in the project area.

Wintering bald eagle use averages about 12 eagles at Rock Island reservoir, 50 eagles at Rocky Reach reservoir, and 22 eagles at Wells reservoir (Fielder 1999 personal communication; Hallett 1994, 1995, 1996, 1997). Waterfowl, especially coots, are the main food source of wintering bald eagles in the area. Cottonwood and ponderosa pine trees provide important perch sites for these eagles. Nesting and wintering bald eagles have also been observed in the lower reaches of the project area tributaries, where adequate nest and perch sites and concentrations of waterfowl are present (WDFW 1999).

Northern Spotted Owl

The northern spotted owl is associated with dense forests that contain structural features characteristic of old-growth forests (i.e., multiple canopy layers, large diameter live trees, and snags) (Thomas et al. 1990). On the east side of the Cascade mountains, these owls forage mostly on small mammals, especially northern flying squirrels (*Glaucomys sabrinus*) and bushy-tailed woodrats (*Neotoma cinerea*) (Forsman et al. 1984). Northern spotted owls have been recorded in the upper reaches of the riparian forests in the Wenatchee and Entiat watersheds (WDFW 1999).

Gray Wolf

Gray wolves have been eliminated from most areas of Washington State, and their current range is strongly influenced by the presence/absence of humans and development (Johnson and Cassidy 1997). Within remote areas, they use a variety of habitats (Johnson and Cassidy 1997). Prey species include ground squirrels, hares, rabbits, deer, elk, and bighorn sheep (Ingles 1965). Gray wolves are not present in the project area vicinity and their presence in the tributary watersheds is limited to remote areas (WDFW 1999).

Grizzly Bear

Grizzly bears are rare in Washington State, with a minimum of 10 to 20 bears estimated in the north Cascades and 26 to 36 bears in the Selkirk range (including Canada) (Johnson and Cassidy 1997). As with gray wolves, grizzlies are limited to remote environments, but within these areas, they utilize a variety of habitats (Johnson and Cassidy 1997). Grizzly bears are opportunistic, omnivores, and their diet includes fish, rodents, carrion, insects, and plants (Mealey 1980; Hamer et al. 1977). These bears are not present in the project area vicinity and their presence in the tributary watersheds is limited to remote areas.

TABLE 3-11. THREATENED, ENDANGERED, AND SENSITIVE WILDLIFE SPECIES OCCURRING OR POTENTIALLY OCCURRING IN THE MID-COLUMBIA PROJECT AREA AND ASSOCIATED TRIBUTARIES

			Occurrence[1]				
				Tributaries			
	Federal Status[2]	State Status[3]	Project Area[4]	Wenatchee[5]	Entiat[5]	Methow[5]	Okanogan[5]
Mammals							
California bighorn sheep (*Ovis canadensis*)	SC	none	yes	yes	yes	no	yes
California wolverine (*Gulo gulo*)	SC	C	no	yes	no	yes	no
Canada lynx (*Lynx canadensis*)	P	T	no	yes	yes	yes	yes
Fringed myotis (*Myotis thysanodes*)	SC	M	no	yes	no	no	no
Gray wolf (*Canis lupus*)	E	E	no	yes	yes	yes[6]	no
Grizzly bear (*Ursus arctos*)	T	E	no	yes	yes	yes	yes
Long-eared myotis (*Myotis evotis*)	SC	M	no	no	no	no	no
Long-legged myotis (*Myotis volans*)	SC	M	no	no	no	yes	no
Pacific fisher (*Martes pennanti*)	SC	E	no	no	no	no	no
Townsend's big-eared bat (*Plecotus townsendii*)	SC	C	no	no	no	no	no
Small-footed myotis (*Myotis ciliolabrum*)	SC	M	N/A	N/A	N/A	N/A	N/A
Spotted bat (*Euderma maculatum*)	none	M	no	no	no	no	yes
Western gray squirrel (*Sciurus griseus*)	SC	T	no	no	no	yes	yes
Yuma myotis (*Myotis yumanensis*)	SC	none	no	no	no	no	no
Birds							
American white pelican (*Pelecanus erythrorhynchos*)	None	E	yes	no	no	no	yes
Bald eagle (*Haliaeetus leucocephalus*)	T	T	yes	yes	no	yes	yes
Black tern (*Chlidonias niger*)	SC	M	N/A	N/A	N/A	N/A	N/A

TABLE 3-11. THREATENED, ENDANGERED, AND SENSITIVE WILDLIFE SPECIES OCCURRING OR POTENTIALLY OCCURRING IN THE MID-COLUMBIA PROJECT AREA AND ASSOCIATED TRIBUTARIES (CONTINUED)

	OCCURRENCE[1]						
				TRIBUTARIES			
	FEDERAL STATUS[2]	STATE STATUS[3]	PROJECT AREA[4]	WENATCHEE[5]	ENTIAT[5]	METHOW[5]	OKANOGAN[5]
Black-backed woodpecker (*Picoides arcticus*)	none	C	no	no	no	yes[6]	no
Burrowing owl (*Speotyto cunicularia*)	SC	C	no	no	no	no	yes
Columbian sharp-tailed grouse (*Tympanuchus phasianellus*)	SC	T	yes	no	no	yes	yes
Common loon (*Gavia immer*)	none	C	yes	yes	no	no	yes
Ferruginous hawk (*Buteo regalis*)	SC	T	no	no	no	no	no
Flammulated owl (*Otus flammeolus*)	none	C	no	yes	no	no	no
Golden eagle (*Aquila chrysaetos*)	none	C	yes	no	no	yes	yes
Great blue heron (*Ardea herodias*)	none	M	yes	yes	no	no	yes
Great gray owl (*Strix nebulosa*)	none	M	no	no	no	yes	yes
Harlequin duck (*Histrionicus histrionicus*)	SC	none	no	yes	no	yes	no
Little willow flycatcher (*Empidonax traillii*)	SC	none	N/A	N/A	N/A	N/A	N/A
Lewis' woodpecker (*Melanerpes lewis*)	none	C	no	yes	no	no	no
Loggerhead shrike (*Lanius ludovicianus*)	SC	C	no	no	no	no	no
Northern goshawk (*Accipiter gentilis*)	SC	C	no	yes	yes	yes	no
Northern spotted owl (*Strix occidentalis*)	T	E	no	yes	yes	yes[6]	no
Olive-sided flycatcher (*Contopus borealis*)	SC	none	N/A	N/A	N/A	N/A	N/A
Osprey (*Pandion haliaetus*)	none	M	yes	yes	yes	no	yes
Peregrine falcon (*Falco peregrinus*)	SC	E	no	yes	no	yes	no
Pileated woodpecker (*Dryocopus pileatus*)	none	C	no	no	no	yes	yes
Red-necked grebe (*Podiceps grisegena*)	none	M	no	no	no	no	no
Sandhill crane (*Grus canadensis*)	none	E	yes[7]	no	no	no	no

TABLE 3-11. THREATENED, ENDANGERED, AND SENSITIVE WILDLIFE SPECIES OCCURRING OR POTENTIALLY OCCURRING IN THE MID-COLUMBIA PROJECT AREA AND ASSOCIATED TRIBUTARIES (CONTINUED)

			Occurrence[1]				
				Tributaries			
	Federal Status[2]	State Status[3]	Project Area[4]	Wenatchee[5]	Entiat[5]	Methow[5]	Okanogan[5]
Three-toed woodpecker (*Picoides tridactylus*)	none	M	no	yes	no	yes	yes
Vaux's swift (*Chaetura vauxi*)	none	C	no	yes	no	no	no
Western bluebird (*Sialia mexicana*)	none	C	no	no	no	yes	no
Western grebe (*Aechmophorus occidentalis*)	none	M	yes[7]	no	no	no	no
Western sage grouse (*Centrocercus urophasianus*)	SC	T	no	no	no	no	no
White-headed woodpecker (*Picoides albolarvatus*)	none	C	no	no	no	yes[6]	no
Amphibians							
Cascades frog (*Rana cascadae*)	SC	none	N/A	N/A	N/A	N/A	N/A
Columbia spotted frog (*Rana luteiventris*)	SC	C	yes	yes	no	yes	yes
Tailed frog (*Ascaphus truei*)	SC	M	no	yes	yes	yes	no
Tiger salamander (*Ambystoma tigrinum*)	none	M	no	no	no	no	no
Reptiles							
Northern sagebrush lizard (*Sceloporus graciosus*)	SC	none	no	no	no	no	no
Mollusks							
Giant Columbia River limpet (*Fisherola nuttalli*)	none	C	no	no	no	yes	yes
Giant Columbia River spire snail (*Fluminicola columbiana*)	SC	C	no	yes	no	yes	yes
California floater (*Anodonta californiensis*)	SC	C	no	no	no	no	no

[1] = species presence or species habitat listed in WDFW records. For nongame species with no State status, this category is not applicable (N/A), because WDFW does not keep records for these species.
[2] E= Federally listed as endangered, T = Federally listed as threatened, P = proposed for listing, SC = species of concern.
[3] E = State listed as endangered, T = State listed as threatened, C = candidate for State listing, M = State listed as priority species.
[4] = includes aquatic and riparian areas from the tailrace of Rock Island Dam to the tailrace of Chief Joseph Dam.
[5] = includes aquatic and riparian areas of the river and its tributaries.
[6] = USFS (1995) documented this species presence in the area.

TABLE 3-11. THREATENED, ENDANGERED, AND SENSITIVE WILDLIFE SPECIES OCCURRING OR POTENTIALLY OCCURRING IN THE MID-COLUMBIA PROJECT AREA AND ASSOCIATED TRIBUTARIES (CONTINUED)

[7] = Fielder (1999 personal communication) documented this species presence in the project area.

Federally Proposed Species and Species of Concern

No wildlife or plant species currently proposed for Federal listing are known to breed or reside in the aquatic and riparian habitats of the project area, and one proposed species, the Canada lynx, occurs in the vicinity of the associated tributaries (WDFW 1999). There are 37 species of concern that potentially occur in the project area and associated tributaries (see Table 3-11) (WDFW 1999). Species of concern include nine mammal species, 11 birds, three amphibians, one reptile, 2 mollusks, and 11 plant species. Most of these species are likely to be present in the immediate vicinity of the project area and tributaries. However, species associated with forested areas, small streams, and remote areas (i.e., California wolverine, Pacific fisher, burrowing owl, northern goshawk, and tailed frog) are not expected to occur in the project area, as suitable habitat is not available.

State Listed Species

State threatened and endangered species present in both the project area and associated tributaries are the American white pelican, Colombian sharp-tailed grouse, and bald eagle (see Table 3-11) (WDFW 1999). In addition the peregrine falcon, northern spotted owl, Canada lynx, gray wolf, grizzly bear, and western gray squirrel, are known to occur in the immediate vicinity of the tributaries (WDFW 1999). One sandhill crane sighting was recorded in the mid- 1970s in the project area, but no records for this species exist for the tributaries (Fielder 1999 personal communication, WDFW 1999). Provided below are State-listed species not previously discussed.

American White Pelican

American white pelicans are colonial nesters that usually breed on isolated islands in freshwater lakes (WDFW 1999). Nesting success is influenced by human disturbance, mammalian predators, flooding, and erosion. This species requires shallow waters for foraging, such as lake and river edges, and open areas within marshes (WDFW 1999). The prey base of American white pelicans consists of fish, amphibians, and crustaceans. Over 100 white pelicans regularly use the Wells reservoir from May to early October (Hallet 1994, 1995, 1996, 1997), and this species has also been recorded on the Okanogan River (WDFW 1999).

Sharp-tailed Grouse

The sharp-tailed grouse occurs in grasslands and shrub savanna (Smith et al. 1997). The species is in serious decline, due to conversion of its habitat to agriculture and other uses (Smith et al. 1997). Sharp-tailed grouse have been recorded near the shoreline of the Mid-Columbia and Okanogan rivers (WDFW 1999). However, this species is predominantly associated with upland habitats.

Peregrine Falcon

The continental peregrine falcon is a rare and local breeder in eastern Washington (Smith et al. 1997). This species was formerly extirpated from the State, but is now being reintroduced at certain locations (Smith et al. 1997). The habitat associations of these reintroduced birds are not well understood. The single record of this species in the project and tributary vicinity is from a tributary of the Beaver Creek and the Methow watershed (WDFW 1999).

Canada Lynx

In Washington State, lynx are found above the 4,500 foot elevation in forested environments (WDFW 1991). The population dynamics of lynx are largely dependent on snowshoe hares, their main prey (WDFW 1991). When hare abundance is high, lynx densities are generally high as well; when hare abundance is low, lynx densities are generally low. Denning sites of lynx are most often in mature forests older than 200 years (WDFW 1991). Lynx are not present in the project area, as suitable habitat is not available. However, lynx have been reported in the vicinity of the project area tributaries (WDFW 1999).

Western Gray Squirrel

In eastern Washington, western gray squirrels are found in walnut tree groves planted by early settlers

(Ryan and Carey 1995). The walnuts provide the primary food source for the squirrels. Other factors important to western gray squirrels are availability of large trees for nesting and proximity to water (WDFW 1991). Western gray squirrels are not present in the project area, but do occur in riparian areas in the Methow and Okanogan watersheds (WDFW 1999).

Sandhill Crane

Sandhill cranes are found in large tracts of open habitat, where visibility is good from all vantage points (WDFW 1991). Nesting sites are generally in shallow water marshes that have dense emergent plant cover, and feeding grounds include meadows, grasslands, and grainfields (WDFW 1991). During 1976, Paul Fielder, wildlife biologist for Chelan County PUD, observed two sandhill cranes along the Wells reservoir, but no other records exist for this species in the project area or the associated tributaries (Fielder 1999 personal communication, WDFW 1999). This species is probably a rare migrant in the project area.

State Candidate and Monitor Species

State candidate species are species that are proposed for listing as threatened or endangered. Monitor species include wildlife species for which WDFW monitors status and distribution. Little is known about many of these species, but biologists are concerned about their well-being.

State candidate species known to occur in the project area include common loons and golden eagles (see Table 3-11) (WDFW 1999). In addition, burrowing owls, California wolverines, Columbia spotted frogs, flammulated owls, Giant Columbia River limpets, Giant Columbia spire snails, black-backed woodpeckers, Lewis' woodpeckers, white-headed woodpeckers, northern goshawks, pileated woodpeckers, Vaux's swifts, and western bluebirds are known to occur in the aquatic and riparian habitat of the project area tributaries (WDFW 1999).

Two State monitor species, the osprey and great blue heron, occur in both the project area and their associated tributaries (WDFW 1999). Several osprey nests are located along the project area reservoirs and a great blue heron rookery is present near Rock Island reservoir (Fielder 1999 personal communication). Western grebes (monitor species) have been observed at the reservoirs and are likely to be present in the lower reaches of the project area tributaries. Four other State monitor species (the spotted bat, great gray owl, three-toed woodpecker, and tailed frog) are known to occur in the tributaries only (WDFW 1999).

State Priority Habitats

Riparian zones, wetlands, islands, talus slopes, cliffs/bluffs, and shrub-steppe habitats are present throughout the immediate vicinity of both the project area and associated tributaries. Waterfowl concentration areas occur along Wells, Rocky Reach, and Rock Island reservoirs, and in the lower reaches of the project area tributaries. Old-growth/mature forest, alpine and meadow habitats, snag-rich areas, aspen stands, and high quality instream habitats are present, but rare, along the upper reaches of the project area tributaries.

3.5.5.2 Columbia River System

Federally listed threatened and endangered wildlife species that use aquatic and riparian habitats of the Columbia River System include the bald eagle, northern spotted owl, Steller sea lion (*Eumetopias jubatus*), and marbled murrelet (*Brachyramphus marmoratus*).

General habitat associations and habitat use of bald eagles and northern spotted owls are described in Section 3.5.4.1. Marbled murrelets forage on inland saltwaters and on the ocean within 1.2 miles of shore (WDFW 1991). These birds nest in mature and old-growth forests within 50 miles of the ocean (WDFW 1991; Csuti et al. 1997). The Columbia River, at its confluence with the Pacific Ocean, provides foraging habitat for marbled murrelets, with possible breeding evidence here as well (Smith et al. 1997).

Steller sea lions occur in coastal waters and use rocky shorelines and islands for haul outs and rookeries. Their diet consists primarily of fish, squid, and octopus (Osborne et al. 1988). Their use of the Columbia River system includes a haul out at the mouth of the river (Brueggeman 1992) and occasional foraging in the Columbia River estuary.

3.6 LAND OWNERSHIP AND USE

3.6.1 PROJECT AREA

3.6.1.1 Wells Dam

Wells Dam, owned by Douglas County PUD, encompasses approximately 60 acres and includes the 4,460-foot dam, a powerhouse integrated into the dam itself, transmission facilities, and a fish hatchery complex.

The Wells Project has a large fish hatchery located on the west side of the dam, another located on the Methow River, as well as the Cassimer Bar sockeye salmon hatchery. The Methow Hatchery also has three fish acclimation ponds on the Chewuch, Twisp and mainstem Methow rivers (see Figure 1-5). Recreational facilities were constructed as part of the dam project, and include Marina Park in Bridgeport, Columbia Cove Park in Brewster, Memorial Park in Pateros, and the Wells Dam Overlook Park next to the dam. The park at the dam site consists of lawn, picnic shelters, restrooms, an interpretive area, and a petroglyph display. The other parks are described in more detail in Section 3.8.

The area surrounding the Wells Dam is mostly privately owned land that is used for orchards, rangeland, and residences. Douglas County PUD owns most of the shoreline lands surrounding the Wells Reservoir. Federal lands managed by the BLM are located east (a small parcel close to the dam) and west (a larger parcel located 2 miles away) of the dam. Five miles to the northwest are the forest lands of the Okanogan National Forest. Recreation is a principal use near the dams and reservoirs.

3.6.1.2 Rocky Reach Dam

The Rocky Reach Dam complex, owned by Chelan County PUD, is spread over approximately 75 acres and includes the dam, powerhouse, visitor information center, fish hatchery, and park (Chelan County PUD 1997b). The 2,500-foot Rocky Reach Dam creates a 43-mile reservoir (Lake Entiat) encompassing approximately 98,000 acres. Rocky Reach’s reservoir provides approximately 35,000 acre-feet of storage.

Fish-related facilities at the dam include passage structures and a fish hatchery. Rocky Reach also has a visitor information center and park. The visitor center attracts over 100,000 visitors annually. The visitor center has a lobby, restaurant, theatre, and fish viewing room. The facility also includes two interpretive museums: the Gallery of Electricity and the Gallery of the Columbia. The museum houses exhibits and displays that relate the early history along the Columbia River, the construction and operation of the dam, and a history of electricity and its generation. Adjacent to the information center is a 30-acre park featuring a picnic area, playground, lawn, and gardens.

A broad river valley surrounds the Rocky Reach Dam and there are several land uses located adjacent to the dam. These mainly include apple orchards that line both sides of the Columbia River. However, there are also private residences, a residential subdivision, some commercial uses, and Lincoln Rock State Park.

Similar to Wells Dam, Rocky Reach was required to develop parks and recreation areas. Daroga State Park, Lincoln Rock State Park, Orondo Park, Entiat Park, Chelan Falls Park, and Beebe Bridge Park are part of the Rocky Reach project. These parks are discussed in more detail in Section 3.8.

State and Federally-owned lands are also located in the vicinity of Rocky Reach. The Swakane State Wildlife Recreation area encompasses the area above and to the west of the dam site. Further west of the dam is Wenatchee National Forest land. Most of the land located east of the dam is privately owned, except for some interspersed Federal public lands that are managed by the BLM.

3.6.1.3 Rock Island Dam

The Rock Island Dam complex, owned by Chelan County PUD, consists of a 3,800-foot dam, two powerhouses, transmission towers and lines, a fish hatchery complex, maintenance facilities, and offices. The dam is a run-of-river type that does not have significant water storage capacity (7,500 acre-feet of storage). However, the dam creates a 21-mile reservoir covering an area of approximately 3,300 acres (Chelan County PUD 1997a).

The dam complex's fish hatchery facilities are composed of a central hatchery located at the dam site and five satellite hatcheries located away from the dam. As part of the dam's development, several recreational sites were constructed and became part of the dam's Federal operating license. These include Wenatchee Riverfront Park, Walla Walla Point Park, Wenatchee Confluence State Park, and Rock Island Hydro Park. These parks are discussed in more detail in Section 3.8.

Land ownership and uses in the vicinity of the dam includes private, State, and Federal lands used for recreation, conservation, range land, and private residences. State and Federally-owned lands are located generally east, west, and south of the dam. Approximately 3 miles south of the dam is the Colockum State Wildlife Recreation Area. Located east and west of the dam are public lands administered by the BLM. These Federal lands are mostly located along Rock Island Creek and Douglas Creek east of the dam and on Wenatchee Heights west of the dam, and are interspersed among privately owned land. Located a few miles north of the dam is the ALCOA aluminum plant. There are no adjacent land uses because of the steep bluffs located next to the Columbia River in this area.

3.6.2 <u>LICENSE REQUIREMENTS</u>

The original licenses for the Wells, Rocky Reach, and Rock Island projects include by reference general terms and conditions by FERC for major projects. These general conditions do not directly address land use, except for Article 8, which states:

In the construction and maintenance of the Project, the location and standards of roads and trails, other land uses, including the location of quarries, borrow pits, spoil disposal areas, and sanitary facilities, shall be subject to the approval of the department or agency of the United States having supervision over the lands involved.

Similarly, Article 48 for the Wells hydroelectric project provides the licensee the authority to grant permission for certain types of use and occupancy of project lands and waters if the proposed use and occupancy is consistent with the purposes of protecting and enhancing the scenic, recreational, and other environmental values of the project.

Subsequent amendments to the licenses have added specific requirements for public access for recreation, but do not otherwise address land use. Generally, the FERC licenses require licenses to allow public access, to a reasonable extent, to project waters and adjacent public lands for navigation and outdoor recreational purposes, including fishing and hunting.

3.6.3 <u>ASSOCIATED TRIBUTARIES</u>

The tributaries associated with the three dams mainly lie within a three county area that includes Douglas, Chelan, and Okanogan counties. Within this area, the main land use surrounding three of the major tributaries (Wenatchee, Entiat, and Methow rivers) is the National Forest lands of the Wenatchee and Okanogan National Forests. Major land uses and ownership for each of the three counties is characterized below.

3.6.3.1 Chelan County

Approximately 80 percent of Chelan County is mountainous, sparsely to heavily forested and undeveloped. Much of the county's land area is reserved for conservation, habitat, forestry, and outdoor recreation, because either the USFS or National Park Service owns approximately 74 percent of the county. The State also owns several wildlife recreation areas including Swakane, Entiat, and Chelan Butte. The State also owns the Ice Caves Heritage area located north of Chelan.

The majority of development has largely been restricted to the narrow valley floors around the Wenatchee and Entiat rivers and Lake Chelan. The major land use activity within the river valley areas of the Wenatchee and Entiat rivers is agricultural, consisting largely of the production of apples and soft fruits. The amount of land used for agricultural purposes remains fairly constant. Although orchard lands are being converted to residential/commercial use in the urban fringe areas around Wenatchee, this trend is offset by expansion of irrigation districts to previously unused land. The conversion of unused land to residential, agronomic and recreational use is expected to continue.

Industrial development is limited. For the most part, industrial activities are located along the Columbia River in the Wenatchee/East Wenatchee urban area. There are some manufacturing activities within the agricultural areas, most of which are associated with the fruit production industry.

The main residential and commercial concentrations are located in and around the incorporated towns and cities. There are extensive year round and summer home developments along the shores of lower Lake Chelan and to lesser degree around Lake Wenatchee. Some limited tourist commercial activities are located along U.S. Highway 2 up through the Wenatchee valley. Leavenworth, at the upper end of the valley, has developed extensive tourist commercial facilities. Substantial residential growth has occurred in the Wenatchee area.

3.6.3.2 Douglas County (Greater East Wenatchee)

Unlike Chelan County where most of the land is mountainous and therefore undeveloped, approximately 80 percent of the land in Douglas County is flat or rolling and suitable for agricultural purposes or range. The rolling plateau from Waterville to Banks Lake is primarily used for grain production, while the lowland areas are engaged in the production of apples, pears and soft fruit. Near the Columbia River there is a narrow floodplain that provides level areas where urban development and apple orchards have been established. The valley sides of the Columbia River are fairly steep, making them generally unsuitable for development.

In contrast to Chelan and Okanogan counties, Douglas County does not have a large percentage of Federal or State land ownership and thus most of the land is in private ownership. The State owns several wildlife recreation areas including the Central Ferry and Foster Creek State Wildlife Recreation areas. Federal lands (managed by the BLM) are scattered along the Columbia River and some drainage basins such as Rock Island Creek and Douglas Creek.

The greater East Wenatchee urban area is about 31,000 acres in size. About 1/3 of this area is comprised of residential uses with commercial and industrial land uses accounting for another 10 percent of the urban area. As stated previously, residential development in the East Wenatchee area has accelerated during the last 5 years and is a trend that is expected to continue.

3.6.3.3 Okanogan County

The western half of Okanogan County is dominated by dense, rugged and mountainous terrain that comprises much of the Okanogan National Forest.

Agricultural uses are concentrated in the central portion of the county mainly along the county's major river valleys of the Columbia, Okanogan, and Methow rivers. The southeast corner of the county is covered by the extensive holdings of the Colville Indian Tribe.

Timber, habitat, conservation, and recreation are the main uses of the National Forest land in the county. These uses in particular surround the Methow River valley. The State also owns the Methow State Wildlife Recreation Area that rings the Methow River valley.

Agriculture, pasture, and residential ranches are some of the chief uses found in the unincorporated areas of the Methow and Okanogan river valleys. Similar to the other counties, apples, pears, and soft fruits are the main crops along with hay.

Residential areas are found primarily around the county's incorporated cities and towns, and in the larger unincorporated communities in the county. Commercial and industrial development is also found in the larger cities, such as Oroville, Tonasket, Omak, Okanogan, Brewster, Pateros and Twisp. In particular, Omak, the county center for services and trade is experiencing an increasing rate of growth.

3.6.4 COLUMBIA RIVER SYSTEM

The land ownership and uses in the Columbia River basin are a reflection of the settlement pattern and history of the area. Native cultures were concentrated in the river valleys and early explorers reported populations of Indians as high as 50,000 along the Columbia and Snake rivers. Particularly important locations were major fishing areas located around falls and rapids. Early settlers used the river system for transportation and trading settlements soon sprang up around the rivers.

In the late 1800s, fertile soils, abundant natural resources, liberal Federal land dispersal policies (Homestead Act, Donation Land Act, Timber Culture Act, and Desert Land Act), and development of the railroad all helped to spur development of interior areas of the State, particularly the Columbia basin. One result of the U.S. Government's influence in settling the region was the granting of land for the railroad in the 1860s and 1870s. Congress made a series of land grants to the railroads each of which was 640 acres in size. However, these land grants alternated on either side of the rail lines. Many of the grants were sold off to private individuals or timber companies, while others were retained in Federal ownership. This resulted in a checkerboard pattern of intermingled Federal and private land ownership (Foster Wheeler 1995) that still exists today.

In the early 1900s, large public works projects particularly hydroelectric and irrigation, caused further development of both urban and agricultural areas such as Grand Coulee and Electric City. Cheap and abundant power also attracted wartime industries such as aluminum companies to the area in the 1940s.

In general, existing land uses typical of the Columbia River basin include cropland, forest, range, and urban development. Cropland uses include pasture, orchards, nurseries, and dry and irrigated lands used to grow crops. Forestry uses include commercial timber harvest, wildlife habitat, and open space. Natural meadow areas and the dry shrub-steppe land cover are largely used as rangeland. Most of the commercial and industrial land uses are concentrated in the urban areas of the Columbia basin.

Land ownership or management of property in the Columbia basin is a mixture of Federal, State, private, and tribal interests. More than 20 Federal agencies manage lands within the basin. The primary agencies are the USFS, BLM, National Park Service, USFWS, BOR, Army Corps of Engineers, and defense agencies, such as the U.S. Army, and U.S. Department of Energy (USDOE).

State owned lands are generally managed for timber harvest, mining, wildlife habitat conservation, grazing, and recreation (Foster Wheeler 1995). There are a few relatively large areas of State ownership near the Columbia River and its tributaries and these are generally wildlife recreation areas. However, there are also lands that were granted to the State from the Federal government. These were grants of sections within each township (sections 16 and 36). As with the railroad grants, this has resulted in a checkerboard pattern of evenly scattered parcels.

Indian Tribes also control large areas of the basin. These Tribes include the Yakama, Colville, and Spokane Tribes. Ownership of tribal lands can be classified into three categories: (1) lands held in trust by the tribal government or Federal government, (2) lands allotted to individual Indians and now held as private Indian lands, or (3) lands allotted to individual Indians which were subsequently sold to non-Indians and now are in private ownership.

3.7 SOCIOECONOMICS – POPULATION, EMPLOYMENT, AND INCOME

The three project area counties are largely rural with relatively low population. In 1997 the population of Washington State was 5,606,800, while the populations of Chelan, Douglas, and Okanogan Counties were 62,200, 30,800, and 38,400 people, respectively. Together, the three counties contain just 2.3 percent of the State population while covering 10,010 square miles, or 15 percent of the State. Since 1990 Washington State population increased by 740,137 or 15.2 percent. Similarly the study area counties have grown at the same or a faster rate. During this period, Chelan County grew by 9,950 persons (19 percent), Douglas County by 4,595 (17.5 percent), and Okanogan County by 5,050 (15.1 percent) (Washington Department of Employment Security 1998b).

Future population growth for the three area counties is generally expected to exceed the Statewide rate of growth. By 2010 Washington State is expected to have 6,693,325 persons, 38 percent more than in 1990. Chelan County will reach 76,093 by 2010, a 46 percent increase from 1990. Douglas and Okanogan counties will increase 51 and 32 percent over the same period to reach populations of 39,596 and 44,061, respectively. (Washington Office of Financial Management 1995).

Statewide, 57 percent of the population lives in incorporated areas. Chelan County is roughly similar, with 45 percent of the population in incorporated places. Wenatchee is its largest city, with 25,160 persons in 1997. Other Chelan County cities and towns include Chelan (population 3,350), Leavenworth (population 2,230), Cashmere (population 2,720) and Entiat (population 801). Douglas and Okanogan counties are more rural with 32 and 40 percent, respectively, of their population in incorporated areas. The largest cities in Douglas County are East Wenatchee (population 5,245), Bridgeport (population 2,060) and Waterville (population 1,109). In Okanogan County, the largest cities are Omak (population 4,495), Okanogan (population 2,415), and Brewster (2,055). (Washington Office of Financial Management 1997).

The three project area counties have proportionately more persons of Hispanic origin (persons of Hispanic origin can be of any race) than the State as a whole, largely due to the amount and type of agricultural employment. Chelan, Douglas, and Okanogan counties were 16, 17, and 18 percent Hispanic in 1996, compared to 6 percent for the entire State. Native American populations are low in Chelan and Douglas Counties, about 1 percent, but are 11 percent of the Okanogan County population due to the presence of the Colville Indian Reservation. Black, Asian, and other races are a small part of the area population (about 1 percent). (Washington Office of Financial Management 1997).

Compared to Washington State, the project area counties have historically had higher unemployment and lower per capita income. Unemployment in 1999 in Chelan, Douglas, and Okanogan counties was 8.4, 6.7, and 9.7 percent, respectively, while the Statewide unemployment rate was 4.8 percent. Statewide average annual income in 1998 was $33,071, while in Chelan, Douglas, and Okanogan counties average annual income was $21,933, $19,613, and $18,106. (Washington Office of Financial Management 2000).

Consistent with their rural character, employment in the area counties is much higher in agriculture and forestry and lower in manufacturing compared to the entire State where agriculture, forestry and fishing comprise 3.7 percent of the jobs and manufacturing comprises 14.1 percent of State-wide employment (Table 3-12). Washington State is the nation's largest grower of apples, and the three counties produce 35 percent of the State's output. The apple industry has suffered in recent years. The value of the State's 1997 apple crop dropped $90 million from the previous year with production down about 9 percent. Growers harvested a record crop in 1998. Prices, however, declined sharply even though many apples were left on the tree. The price for processing apples was often below the cost of harvesting. Prices and demand have been affected by the Asian financial crisis and a tariff imposed by Mexico.

Other important fruits grown in the area include pears and sweet cherries. As a consequence of the high level of agriculture, employment varies substantially by season. Employment in government is similar to the rest of the State, but accounts for a much higher portion of the total wages paid. Both employment and wages in the service sector are similar to the entire State. In Chelan County, agriculture is the largest sector in terms of employment, although not in terms of wages paid due to the seasonal nature and large number of relatively low skilled jobs. Fruit, led by apples, is the major crop. The primary fruit growing areas are along river valleys where water is available for irrigation and natural air drainage produces a favorable climate. In the manufacturing sector, aluminum is the largest industry. This industry is made possible by the availability of large quantities of low-cost electricity.

Wages in manufacturing are relatively high and contribute substantially to the County's economy. In the service sector, health care is the leading industry and accounts for almost half of the sector's employment. This industry also pays relatively high wages. Hotels and lodging are also important in the services sector. Chelan County attracts a relatively large number of tourists and recreationalists, making the lodging the second largest industry in the sector. However, this industry is seasonal and pays relatively low wages, reducing its importance to the local economy.

TABLE 3-12. PERCENT TOTAL EMPLOYMENT AND WAGES PAID FOR SELECTED SECTORS, 1998

	WASHINGTON STATE		CHELAN COUNTY		DOUGLAS COUNTY		OKANOGAN COUNTY	
	% TOTAL EMPLOY-MENT	% OF AVERAGE WAGE	% TOTAL EMPLOY-MENT	% OF AVERAGE WAGE	% TOTAL EMPLOY-MENT	% OF AVERAGE WAGE	% TOTAL EMPLOY-MENT	% OF AVERAGE WAGE
Ag. For., Fish.	3.7	47.2	23.5	55.1	34.0	65.2	31.2	55.7
Manf.	14.4	127.7	7.2	147.8	2.3	108.7	5.4	139.4
Retail	17.8	54.2	16.9	68.1	17.3	75.1	12.6	72.4
Services	26.1	108.5	19.0	106.4	13.2	114.5	18.0	102.2
Govnt.	17.0	102.4	16.2	148.5	19.7	156.1	20.3	163.5

Source: Washington Office of Financial Management 2000

The tourist industry also supports a substantial portion of the retail sector. In the government sector, local government related to education accounts for half of the employment. State government employment is split roughly between community colleges and the Department of Transportation. Federal employment is mostly related to land and wildlife management in the Wenatchee National Forest. All government sector jobs are relatively well-paid.

Agriculture dominates Douglas County employment. As in Chelan and Okanogan counties, fruit growing is very important along river valleys, primarily the Columbia. Douglas County also has large areas on the Columbia plateau where wheat is grown. Wheat production is both dry-land and irrigated. Little manufacturing is based in Douglas County, however some persons employed in manufacturing in the Wenatchee area (Chelan County) live across the Columbia in East Wenatchee (Douglas County).

As in Chelan County, most service sector employment is in health care. Other service sector and retail employment support local businesses and residents and are less dependent on tourism than either Chelan or Okanogan counties. Government is the largest non-agricultural sector in the county, and 87 percent of government employment is in local government, most of which is devoted to education.

Okanogan County is the third largest producer of apples in the State, after Yakima and Chelan counties. Other important fruit crops include cherries and pears. The County also produces large amounts of grains, including wheat, barley, oats, and corn. Much of this agriculture requires irrigation during part of the year. Okanogan County supports large numbers of livestock, including beef, sheep, and lamb. Forestry employment has declined recently due to harvest restrictions and is not expected to regain its once substantial role. Manufacturing is a relatively small part of the County economy. Most of the manufacturing is tied to the timber and wood products industry, and hence has been volatile.

Similar to both Chelan and Douglas counties, health care is the largest industry in the service sector. Another major employer in the service sector is tribal administration for the Colville Indian Reservation. Combined with the Colville Tribal Enterprise (included in the trade sector), Native Americans constitute an important part of the County economy. Government is the second-largest employer in Okanogan County next to agriculture. As in most areas, local government employment in education is largest single employer. The County also has relatively large Federal employment providing maintenance and management of irrigation systems and National Forest lands.

3.8 RECREATION

Recreational opportunities associated with streams and rivers are important to both residents and visitors. Both directly and indirectly, water-related activities and settings define an important part of the area's quality of life and economy. Public and private lands on and near the project area and its tributaries are used for a wide variety of recreational activities.

The original license for the Wells Dam included by reference general terms and conditions by FERC for major projects (FERC 1953). With regards to recreation, Article 7 states:

> So far as is consistent with proper operation of the project, the Licensee shall allow the public free access, to a reasonable extent, to project waters and adjacent lands owned by the Licensee for the purpose of full public utilization of such lands and water for navigation and recreational purposes, including hunting and fishing, and shall allow to a reasonable extent for such

purposes the construction of access roads, wharves, landings, and other facilities…

Policies on recreational use were clarified by Order No. 313, Issuing Statement of General Policy, Recreational Development (FERC 1965). This order encourages preparation of comprehensive recreation plans for all projects. Pursuant to this and other FERC requirements, Douglas County PUD prepared public use and recreation plans for the Wells project that are now part of the project license (FERC 1987b). Recreational facilities and improvements included in the plan are described below in Section 3.8.1. The recreation plan is updated every 5 years.

The original license for the Rocky Reach Dam (FERC 1957a) included the same general terms and conditions regarding recreation described above for the Wells Dam. The recreation plan for the project (Exhibit R), prepared pursuant to Order No. 313 (FERC 1965) and other requirements, was approved in 1976 (FERC 1976). Since the plan's approval, Chelan County PUD has implemented the overall plan, with some small revisions submitted for FERC approval (Chelan County PUD 1991). The facilities and improvements included in the current plan are described below in Section 3.8.1.

The original license for the Rock Island Dam (FERC 1975) included the same general terms and conditions regarding recreation described above for the Wells Dam. Like the Rocky Reach project, a recreation plan was prepared for the project and was approved (FERC 1989a). The plan is being implemented, with a request to expand the camping and picnicking facilities at the North Confluence Park (Chelan County PUD 1992). The facilities and improvements included in the plan are described below in Section 3.8.1.

3.8.1 PROJECT AREA

Tourism and recreation are important to the local economies in the project area. The reservoirs formed by the three dams are popular sites for recreational activities including boating, fishing, camping, and swimming. The following public park facilities are located in the project area as shown in Figure 3-12 (listed proceeding upstream).

3.8.1.1 Rock Island Hydro Park

Rock Island Hydro Park is located on 70 acres 2 miles south of East Wenatchee on State Route 28. The park includes baseball/soccer fields (two with lights), picnic areas, picnic shelter, swimming, boat launch, boat trailer parking, tennis, volleyball, 1.1 miles of trail, restrooms. In 1997, it was recorded that 180,913 people visited the park, while in 1998 the user numbers increased to 181,331 people. The park saw the most users between the July and August months, with the lows occurring in October and November. The park is owned and managed by Chelan County PUD (Chelan County PUD 1999d).

3.8.1.2 Wenatchee Riverfront Park

Wenatchee Riverfront Park is located on 31 acres in downtown Wenatchee along the Rock Island reservoir. The park includes 1.1 miles of shoreline trail, "special event" mini-railroad, ice rink, 2-lane boat launch, short-term moorage, boat trailer parking, restrooms. The park trail connects with Walla Walla Point Park and the Wenatchee State Park to provide 5 miles of paved bicycle and pedestrian trail. This trail connects through bridges to East Wenatchee, where the Apple Capitol Recreation Loop trail follows the east bank of the reservoir. In 1997, 964,654 people visited the park. In 1998, the park saw an increase to 969,804 visitors. The park was busiest between the July and August months, with the lowest amount of activity occurring in October and November. The park is owned and managed by Chelan County PUD (Chelan County PUD 1999d). The East Wenatchee segment of the trail is managed by the Douglas County Parks Department.

3.8.1.3 Walla Walla Point Park

Walla Walla Point Park is located on 70 acres in Wenatchee (and adjoins Wenatchee Riverfront

Park). The park includes a fourplex soccer/softball complex (each with field lights), swimming, 1.2 miles of trail, tennis, volleyball, horseshoe pits, playground equipment, restrooms, picnic shelters, and a special event area. In 1997, it was recorded that 635,649 people visited the park, with the majority of the use occurring during daytime as opposed to overnight park users. In 1998, the user numbers increased to 655,364 people, continuing the same trend of daytime use. The park saw the most users between the July and August months, with the lows occurring in October and November. The park is owned and managed by Chelan County PUD (Chelan County PUD 1999d).

3.8.1.4 Wenatchee Confluence State Park

Wenatchee Confluence State Park is located on 200 acres in Wenatchee on both sides of the Wenatchee River where it joins the Columbia River. The park includes camping (59 tent/recreational vehicle sites: 51 with electricity, water and sewer, 8 standard), baseball/soccer field, 2-lane boat launch, boat trailer parking, swimming, restrooms, showers, picnic shelter, volleyball, tennis, playground equipment, Wenatchee River pedestrian bridge, 4.5 miles of trail, wildlife area, interpretive graphics, and a recreational vehicle dump station. An estimated 362,322 people visited the park in 1997, with the majority of the use occurring during daytime as opposed to overnight park users.

In 1998, the park saw an increase to 485,266 people, continuing the same trend of daytime use. The significant increase in visitors from 1997 to 1998 is primarily due to the flooding that occurred in 1997 that inhibited many visitors from using the park's facilities. The park saw the most visitors between the July and August months, with very low activity occurring in October and November. The park is owned by Chelan County PUD (Chelan County PUD 1999d) and leased to the Washington State Parks and Recreation Commission.

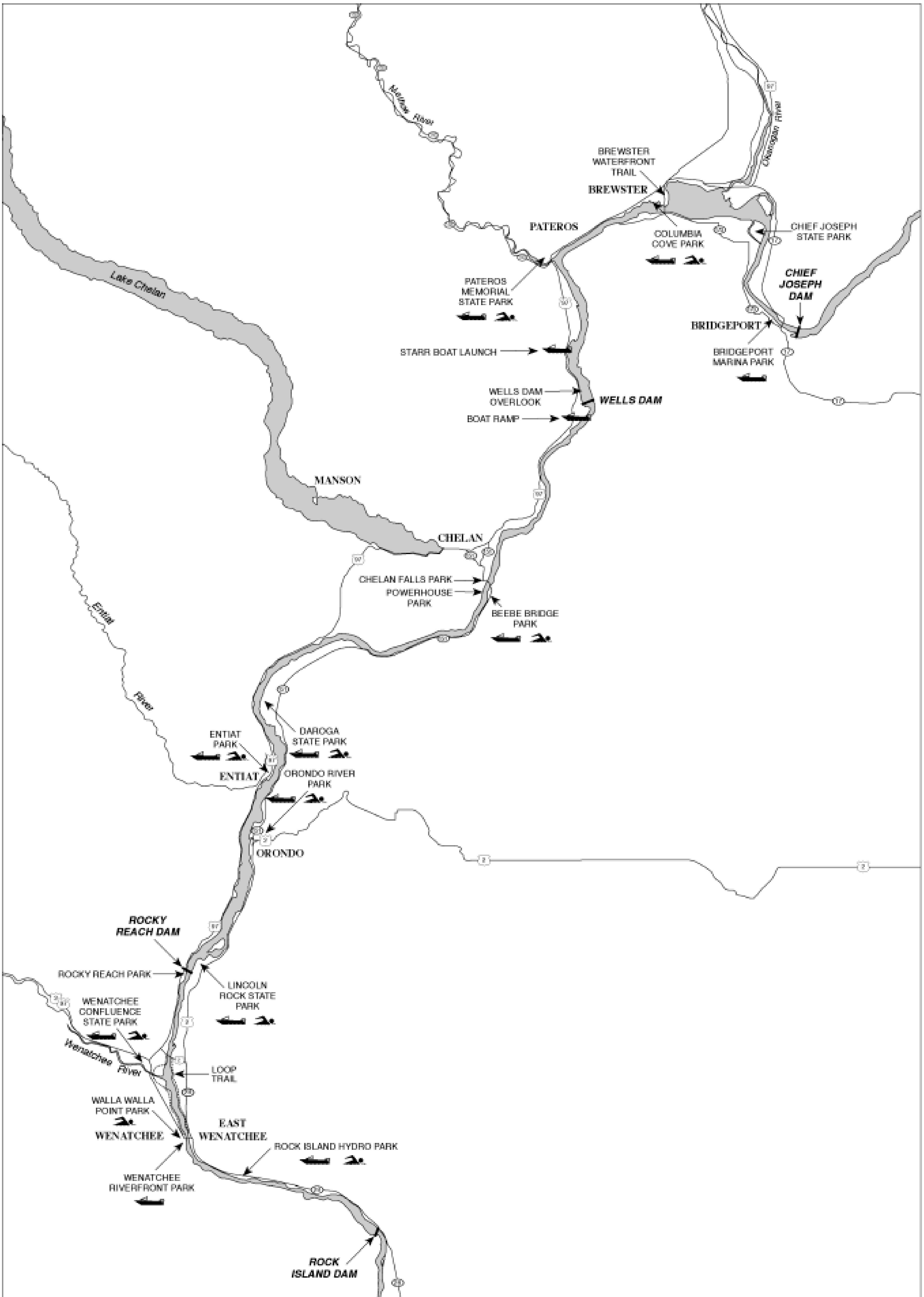
3.8.1.5 Rocky Reach Dam

Rocky Reach Dam and visitor facilities are located on 38 acres, 7 miles north of Wenatchee on State Route 97A. The visitor facilities include extensive, landscaping, picnic areas, picnic shelter, playground equipment, horseshoe pits, visitor center, fish viewing room, historical galleries, and restrooms. In 1997, it was recorded that 88,574 people visited the park, while in 1998 the user numbers decreased to 64,362. The variance in visitors over the 2-year period are attributed to park closures, with the longest closures occurring in 1998. Visitor numbers are usually near the 200,000 plus range, and are expected to return to that level in 1999. Most people visit the park between July and August, with very little activity in October and November. The facilities are owned and managed by Chelan County PUD (Chelan County PUD 1999d).

In support of the relicensing process for the Rocky Reach hydroelectric project, the Chelan County PUD is planning a detailed recreational study to be conducted during 1999. This study will evaluate on and off-season activities and include all recreational facilities in the project area. The study will collect new data from personal interviews, on-site instantaneous observational counts, and time sampling observations of arrival rates. The primary developed recreational facilities that will be studied include Rocky Reach Dam, Entiat Park, Chelan Falls Park, Beebe Bridge Park, Daroga State Park, Orondo River Park, and Lincoln Rock State Park. The report is expected to be completed by the end of 1999.

3.8.1.6 Lincoln Rock State Park

Lincoln Rock State Park is located on 60 acres, 7 miles north of East Wenatchee on State Route 2. The park includes camping (94 tent/recreational vehicle sites: 35 with electricity and water, 32 with electricity, water and sewer, 27 standard), baseball/soccer field, 3-lane boat launch, boat trailer parking, short-term moorage, swimming, restrooms, showers, picnic shelters, playground equipment, volleyball, tennis, horseshoe pits, amphitheater, and



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SCALE IN MILES

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WATER DEPENDENT FACILITIES

Boat Ramp

Swimming Beach

Figure 3-12
Project Area Parks

recreational vehicle dump station. In 1997, it was recorded that 260,186 people visited the park, with the majority of the use occurring during daytime as opposed to overnight park users. In 1998, the user numbers decreased to 232,735 people, but still continued the same trend of daytime use. The decrease in visitors from 1997 to 1998 can be attributed to charges that began in 1998 for daytime park users and also an increase in camping fees. The park sees the most users between July and August, with the lows occurring in October and November. The park is owned by Chelan County PUD (Chelan County PUD 1999d) and is leased to the Washington State Parks and Recreation Commission.

3.8.1.7 Turtle Rock Island

This 1-acre site is reserved as a future park. It is located ½ mile upriver from Lincoln Rock State Park in the Rocky Reach reservoir. The beach is accessed by boat only. No camping or day-use facilities are provided. The site is owned by Chelan County PUD (Chelan County PUD 1999d).

3.8.1.8 Orondo River Park

Orondo River Park is located on 5 acres on the east side of Rocky Reach reservoir, approximately 2 miles north of Orondo. The park includes 13 recreational vehicle sites (10 with electricity and water), showers, swimming, 1-lane boat launch, boat trailer parking, short-term moorage, picnic shelters, concessions, horseshoe pits, JetSki rentals and marine gas available. A total of 35,644 people visited the park in 1997, with the majority of the use occurring during daytime as opposed to overnight park users. In 1998, visitor numbers increased to 36,824, continuing the same trend of daytime use. July and August were the busiest months for visitors, while October and November were the months that had the least amount of visitors. The park is managed by the Port of Douglas County.

3.8.1.9 Daroga State Park

Daroga State Park is located on 140 acres on the east shore of Rocky Reach 8 miles north of Orondo. The park offers camping, 28 tent/recreational vehicle sites with electricity and water, 17 walk-in or boat-in sites, group camping, baseball/soccer field, 2-lane boat launch, boat trailer parking, playground equipment, combination tennis and basketball court, short-term moorage, swimming, restrooms, showers, picnic shelters, volleyball, tennis, 2.5-mile shoreline trail, and a recreational vehicle dump station. In 1997, 116,517 people visited the park, with the majority of the use occurring during daytime as opposed to those using the park for camping purposes. In 1998, visitors increased to 126,797 people, continuing the same trend of daytime use. The park saw the most users between the July and August months, with the lows occurring in October and November. The park is owned by Chelan County PUD (Chelan County PUD 1999d) and is leased to the Washington State Parks and Recreation Commission.

3.8.1.10 Entiat Park

Entiat Park is located on 40 acres on the west side of Rocky Reach reservoir in Entiat. The park includes camping (50 tent sites and 31 recreational vehicle sites with complete hookups), boat launch, boat trailer parking, swimming, restrooms, showers, recreational vehicle dump station, playground equipment, picnic shelter, picnic areas. In 1997; 47,411 people visited the park. The majority of the park was used for daytime activities as opposed to those who used it for camping. In 1998, use increased to 150,278 people, continuing the same trend of daytime use. The significant increase from 1997 to 1998 can be attributed to ‘counting device’ construction changes that occurred near the entrance to the park. A new counter was installed in 1998, replacing an inadequate and often inaccurate counting device. The park saw the most users between the July and August months, with the lows occurring in October and November. The park is managed by the City of Entiat, Parks and Recreation Department.

3.8.1.11 Beebe Bridge Park

Beebe Bridge Park is located on 56 acres on the east shore of Rocky Reach reservoir, 21 miles north of Orlando on State Route 97. The park offers camping, 46 tent/recreational vehicle sites with electricity and water, restrooms, showers, parking, day-use facilities, picnic shelter, swimming area, 2-lane boat launch, short-term boat moorage, tennis courts, playground equipment, horseshoe pits, shoreline trail, recreational vehicle dump station. In 1997, it was recorded that 92,113 people visited the park, with the majority of the use occurring during daytime as opposed to overnight park users. In 1998, there was an increase to 109,928 visitors, the majority still using the park for daytime activities. The park saw the most users between the July and August months, with the lows occurring in October and November. The park is managed by Chelan County PUD (Chelan County PUD 1999d).

3.8.1.12 Wells Dam Overlook

The Wells Dam Overlook is a tree-filled park overlooking the Wells Dam. The park includes a turbine runner from Wells Dam on display, an interpretive area, a petroglyph display, picnic shelter and restrooms. No use estimates are available. The park is managed by Douglas County PUD. Boat launch facilities are provided below Wells Dam and to the north of the dam off of Highway 97.

3.8.1.13 Pateros Memorial Park

Pateros Memorial Park is located in the town of Pateros at the confluence of the Methow and Columbia rivers on the Wells reservoir. The park includes a paved pedestrian walkway along the riverfront, picnic shelters, boat launches, fishing and ski docks, and restrooms. Also in Pateros, Peninsula Park on the Methow has a swimming area, picnic shelter, restrooms and play area. No use estimates are available for either park. Both parks are managed by the City of Pateros. A boat launch facility with toilets is provided on the Methow River just above Pateros and off of State Route 153.

3.8.1.14 Columbia Cove Park

Columbia Cove Park is located in Brewster and is a day use area complete with a sandy beach and swimming area, picnic shelters, boat launch and dock facilities, basketball court, play area, and restrooms. It is located adjacent to ball fields and the city swimming pool. No use estimates are available. The park is managed by the City of Brewster.

3.8.1.15 Brewster Waterfront Trail

The Brewster Waterfront Trail is a ½ mile graveled pedestrian walkway along the Wells reservoir adjacent to the downtown area. The park includes picnic areas and benches. The park is accessible at several locations. No use estimates are available. The park is managed by the City of Brewster. Boat launch facilities, with public toilet, are also provided on the Okanogan River, upstream of Monse.

3.8.1.16 Chief Joseph State Park

This park is located on an island on the south shore of Wells reservoir, west of Bridgeport. The park is largely undeveloped, with a simple boat launch. No motor vehicles are allowed on the island. No estimates of use are available for the park. The park is managed by the Washington State Parks and Recreation Commission.

3.8.1.17 Bridgeport Marina Park

The Bridgeport Marina Park is located adjacent to the Wells reservoir in Bridgeport. The park includes 18 full hook-up recreational vehicle sites, two tent pads, restrooms, a playground, beach and swimming area, boat docks, two boat launches, picnic shelters, and a gazebo. In 1997, it was recorded that 69,108 people visited the park, with the majority of the use occurring during daytime as opposed to overnight park users. In 1998, the user numbers increased to 74,131 people, continuing the same trend of daytime use. The park saw the most users between the July and August months, with the lows occurring in October and November. The park is managed by the City of Bridgeport.

In addition to these public facilities there are many private residences along the reservoir with direct access to the water. Recreation at all sites on the river is most intensive during the summer season, Memorial Day through Labor Day. The opening of fishing season is also a period of peak activity.

3.8.2 ASSOCIATED TRIBUTARIES

The four tributary rivers are popular for a variety of recreational activities. Active recreation on these rivers include kayaking, rafting (private and commercial), other boating, fishing, and swimming. The rivers are indirectly related to camping, hiking, bird watching, and similar outdoor activities that benefit from a waterfront setting.

The Interagency Committee for Outdoor Recreation (IAC) has Statewide responsibility for assisting local, State, and Federal agencies in planning, acquiring, and developing recreational resources. In 1990, the IAC published detailed profiles of each county including an inventory of recreational facilities by type of provider. The IAC is planning on updating this inventory during 1999, however at this time the 1990 report remains the most current source of comparable information for all counties.

Chelan County includes large areas of Federally managed lands used for recreation and other purposes. These include the Wenatchee National Forest, north Cascades National Park, Lake Chelan National Recreation Area, and several wilderness areas. The county has many trails for hiking, horseback riding, and off-road vehicle riding. The Wenatchee River is very popular for recreation. Fishing is now closed except for whitefish in the winter and that may soon be closed as well. Kayaking and commercial whitewater rafting are popular from Leavenworth downstream. Lake Wenatchee, and Wenatchee State Park, are popular locations for swimming, and boating. Both public (USFS) and private campgrounds are located along the entire river. Also in Chelan County, the Entiat River provides a setting for several USFS campgrounds. The 1990 recreational facilities are shown in Table 3-13 (more recent county-wide data on both public and private facilities are not available).

In contrast to Chelan and Okanogan counties Douglas County does not have large areas of land under public ownership. Most camping facilities, especially those with hookups, are provided by the private sector. There are few sporting facilities (Table 3-14) (more recent county-wide data on both public and private facilities are not available). Most of the camping and day use facilities are provided by the private sector. As would be expected from the scarcity of recreational facilities, travel and recreation have a relatively small impact on the local economy in Douglas County.

Similar to Chelan County, Okanogan County has large areas of Federally managed lands used for recreation and other purposes. These include Okanogan and Colville National Forests and Pasayten and Lake Chelan-Sawtooth Wilderness areas. Travel and recreation have a large impact on the county economy (Table 3-15) (more recent county-wide data on both public and private facilities are not available). On the Methow River and below Mazama, most recreational sites are privately operated. Above Mazama, the USFS provides camping and access. The river is used for fishing and rafting, and kayaking. The Okanogan River provides fishing and boating. Most camping facilities on the river are privately operated.

Tourists expend more dollars on hotels in Chelan County, while campground spending is greatest in Okanogan County (Table 3-16). Because of the increased number of hotels in the Wenatchee area, greater tourist employment opportunities occur in Chelan County with a corresponding increase in income from local and State taxes.

TABLE 3-13. RECREATIONAL FACILITIES IN CHELAN COUNTY BY TYPE OF PROVIDER, 1990

	LOCAL	STATE	FEDERAL	PRIVATE	TOTAL
General					
Number of Sites	51	15	84	32	**182**
Developed Acres	527	42,049	838	4,959	**48,373**
Shoreline (feet)	26,464	124,576	196,390	14,390	**361,820**
Boating					
Moorage Slips	36	85	140	470	**731**
Moorage Buoys	0	4	0	26	**30**
Launch Lanes	6	8	0	6	**20**
Trailer Parking	110	313	35	348	**806**
Camping/Day Use					
Total Camp Units	402	454	764	874	**2,494**
Units with Hookups	201	31	0	671	**903**
Day Picnic Tables	363	128	65	ns[1]	**556**
Day Picnic Shelters	14	4	8	ns[1]	**26**
Swimming					
Indoor Pools	1	0	0	0[2]	**1**
Outdoor Pools	4	0	0	6[2]	**10**
Swimming Beach (feet)	2,368	786	0	380	**3,534**
Sports					
Baseball/Softball Fields	52	0	0	ns[1]	**52**
Football/Soccer Fields	22	0	0	ns[1]	**22**
Tennis Courts	35	0	0	14	**49**
Other Courts	35	0	0	ns[1]	**35**
Trail Miles					
Hike	0	25	1,414	ns[1]	**1,439**
Horse	0	5	1,301	ns[1]	**1,306**
Recreational vehicle/Motorcycle	0	0	370	ns[1]	**370**

[1] ns = not surveyed
[2] Private sector data reflects sites with pools only, not total number of pools.

TABLE 3-14. RECREATIONAL FACILITIES IN DOUGLAS COUNTY BY TYPE OF PROVIDER, 1990

	LOCAL	STATE	FEDERAL	PRIVATE	TOTAL
General					
Number of Sites	31	6	1	7	**45**
Developed Acres	247	3,067	58	73	**3,455**
Shoreline (feet)	1,650	32,800	21,120	8,720	**64,290**
Boating					
Moorage Slips	15	66	0	0	**81**
Moorage Buoys	0	0	0	0	**0**
Launch Lanes	3	7	1	4	**15**
Trailer Parking	120	640	30	3,512	**4,302**
Camping/Day Use					
Total Camp Units	33	96	0	285	**414**
Units with Hookups	12	67	0	165	**244**
Day Picnic Tables	135	60	6	ns[1]	**201**
Day Picnic Shelters	10	3	0	ns[1]	**13**
Swimming					
Indoor Pools	1	0	0	0[2]	**1**
Outdoor Pools	3	0	0	1[2]	**4**
Swimming Beach (feet)	0	180	0	0	**180**
Sports					
Baseball/Softball Fields	14	0	0	ns[1]	**14**
Football/Soccer Fields	7	0	0	ns[1]	**7**
Tennis Courts	17	0	0	0	**17**
Other Courts	5	0	0	ns[1]	**5**
Trail Miles					
Hike	0	0	0	ns[1]	**0**
Horse	0	0	0	ns[1]	**0**
Recreational vehicle/ Motorcycle	0	0	0	ns[1]	**0**

[1] ns = not surveyed
[2] Private sector data reflects sites with pools only, not total number of pools.

TABLE 3-15. RECREATIONAL FACILITIES IN OKANOGAN COUNTY BY TYPE OF PROVIDER, 1990

	LOCAL	STATE	FEDERAL	PRIVATE	TOTAL
General					
Number of Sites	76	47	68	33	**224**
Developed Acres	1,053	47,724	525	3,048	**52,350**
Shoreline (feet)	54,970	182,797	199,865	50,525	**488,157**
Boating					
Moorage Slips	0	41	0	38	**79**
Moorage Buoys	0	0	0	0	**0**
Launch Lanes	26	35	11	8	**80**
Trailer Parking	108	1,110	53	94	**1,365**
Camping/Day Use					
Total Camp Units	247	640	1,662	1,271	**3,820**
Units with Hookups	72	103	0	740	**915**
Day Picnic Tables	230	221	96	ns[1]	**547**
Day Picnic Shelters	22	9	2	ns[1]	**33**
Swimming					
Indoor Pools	0	0	0	0[2]	**0**
Outdoor Pools	7	0	0	9[2]	**16**
Swimming Beach (feet)	1,890	1,987	0	500	**4,377**
Sports					
Baseball/Softball Fields	34	0	0	ns[1]	**34**
Football/Soccer Fields	10	0	0	ns[1]	**10**
Tennis Courts	28	0	0	7	**35**
Other Courts	9	0	0	ns[1]	**9**
Trail Miles					
Hike	0	0	1,349	ns[1]	**1,349**
Horse	0	0	1,302	ns[1]	**1,302**
Recreational vehicle/ Motorcycle	0	0	270	ns[1]	**270**

[1] ns = not surveyed
[2] Private sector data reflects sites with pools only, not total number of pools.

TABLE 3-16. ESTIMATED TRAVEL IMPACTS BY COUNTY, 1997

	CHELAN	DOUGLAS	OKANOGAN
Campground Spending ($000)	31,810	1,670	32,940
Hotel, motel, B&B spending ($000)	112,110	6,400	32,410
Travel-generated payroll ($000)	39,680	4,040	18,340
Travel-generated employment	3,650	380	1,690
Local and State taxes ($000)	14,550	1,710	7,190

Source: Dean Runyan Associates 1998

3.9 CULTURAL RESOURCES

Key Terms

Character Defining Features – The components of an historic property that contribute to its historical significance.

Cultural Resource – Nonrenewable evidence of human occupations or activity as seen in any district, site, building, structure, artifact, ruin, object, work of art, architecture, or natural feature associated with the cultural practices or beliefs of a living community.

Historic Integrity – The extent to which a property has retained its original design and setting.

Historic Property – A property listed on the National Register of Historic Places.

National Register of Historic Places – The official federal list of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, engineering, and culture.

Section 106 of the Historic Preservation Act – A federal regulation that requires properties with federal involvement to take into consideration impacts to properties listed in or eligible for the National Register.

The cultural resource properties in the project area include archaeological sites, historical sites, and traditional cultural properties. These properties are defined as a location associated with a "community's historically rooted beliefs, customs, and practices," which may include geographic places and natural resources. [3] Congress developed Section 106 of the National Historic Preservation Act to avoid unnecessary harm to historic properties. Section 106 applies to "properties already listed in the National Register, properties determined eligible for listing, and properties not formally determined eligible but that meet specified eligibility criteria." [4]

Assessment of National Register of Historic Places eligibility entails evaluation of cultural properties identified under a set of criteria specified in 36 CFR 60.4:

The quality of significance in American history, architecture, archaeology, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, material, workmanship, feeling, and association, and:

- that are associated with events that have made a significant contribution to the broad patterns of our history; or
- that are associated with the lives of persons significant in our past; or
- that embody the distinctive characteristics of a type, period, or method of construction or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
- that have yielded, or may be likely to yield, information important in prehistory or history.

3.9.1 PREHISTORIC ARCHAEOLOGY

Archaeologists generally agree that a five-phase system represents a simplified prehistory of the Columbia plateau region, which includes the Rock Island and Rocky Reach dam areas and the areas surrounding the tributaries that flow into the Columbia River near these dams. The prehistory of the Wells Dam area follows a similar, but distinct,

[3] National Register Bulletin 38, Guidelines for Evaluating and Documenting Traditional Cultural Properties, p.1

[4] Advisory Council on Historic Preservation workbook, Section 106, Step-by-Step.

chronological sequence that is described later in this section. The Columbia plateau phases (Clovis, Windust, Vantage, Frenchman Springs, and Cayuse) each represent a time period possessing distinct settlement and/or subsistence patterns. Researchers have interpreted differences between the phases to represent changes in subsistence and settlement systems, or adaptational shifts. Table 3-17 presents a prehistoric sequence for the Columbia plateau, defining the periods in terms of archaeological characteristics and chronological sequence.

Table 3-18 presents the chronological sequence for the Lower Okanogan valley region, which includes the Wells Dam area. The tables show the phases, from top to bottom, from the most recent to the oldest defined for the region. This arrangement mirrors an archaeological stratigraphic profile, with the most youngest materials, deposited most recently, nearest the top. The paragraphs following these tables, which expand on the information presented in them, are presented in chronological order: from oldest to most recent.

Although it is uncertain when people first arrived in the area, the occasional discovery of Clovis projectile points suggests a minimum date somewhere between 12,000 and 11,000 years Before Present (BP). The Clovis point, a large, bifacially-flaked point with a large “flute” or flake scar at the base, is the most diagnostic artifact type of this period (Chatters 1989; Galm et al. 1987; Hollenbeck and Carter 1986; Lothson 1982). In Washington to date, there have been no extensive analyses published on these early materials. The cache of approximately 14 Clovis points discovered near Wenatchee yield proxy tephra dates of post-11,250 BP (Mehringer 1989). Consequently, the characteristics of settlement and subsistence during this period are purely conjectural. Based on evidence from elsewhere in the United States, however, archaeologists believe that Clovis-age settlement consisted of small, highly mobile bands of hunter-gatherers. Although many researchers cite Clovis points as evidence for “big-game hunting,” it is possible that these early inhabitants of the region had a more generalized adaptation, based on the wide distribution of these points in varied environments.

By 10,500 years BP, small, highly mobile bands populated the developing grasslands using a generalized subsistence strategy that was seasonally structured around a complex resource base. Similarly, technological innovations allowed for more intensive use of certain seasonal resources. The most diagnostic artifact is a large, stemmed or lanceolate projectile point. Other stone artifacts include bifacially-flaked knives, wide, flat endscrapers, gravers, burins, bola stones, grooved net sinkers, milling stones, choppers, and simple flake tools. Bone tools include wedges, single-piece and composite harpoons, foreshafts, atlatl spurs, awls, and needles. Sparse scatters of artifacts covering areas no greater than a few hundred square meters suggests small group size and high mobility. Habitation sites included rockshelters, caves, and open areas, that were frequently reused over long periods of time (Chatters 1989; Galm et al. 1987; Hollenbeck and Carter 1986; Lothson 1982).

Riverine sites adjacent to rapids contain an abundance of fish remains and associated artifacts, such as grooved net sinkers and gorges. This evidence indicates increasing intensification of anadromous fish populations in the Columbia and its tributaries. In drier, upland sites, a predominance of milling stones suggests that seed gathering was also an important aspect of subsistence. The diverse composition of faunal and floral remains indicates that subsistence, while still generalized, was increasingly structured by seasonally abundant or available resources (Chatters 1989; Galm et al. 1987; Hollenbeck and Carter 1986; Lothson 1982).

Between 8,000 and 4,500 years BP, inhabitants of the region restricted their range to riverine areas, with some use of upland montane environments. With a gradual warming of the climate, regions became drier and subsistence activities became progressively less variable across the seasons. Inhabitants were probably organized as highly mobile, opportunistic foragers adapted mainly to riverine environments. Graves containing beads of

TABLE 3-17. COLUMBIA PLATEAU CHRONOLOGICAL SEQUENCE

YEARS BP [1]	DESCRIPTION OF CULTURE HISTORICAL PHASES	
150-present	**Historic Period**	**Historic Period.** Euroamericans settle in region.
250-150	**Late Prehistoric Period**	**Ethnographic Period.** Introduction of Euroamerican technology and non-indigenous diseases lead to culture change and significant population collapse for Native American groups.
2500-250	**Late Prehistoric Period** / **Middle Prehistoric Period**	**Cayuse Phase.** Population concentrated in large, nucleated winter villages of 50+ housepits. People dispersed to gather roots in the spring and to hunt in the fall and winter. This seasonal round became increasingly diverse and well organized over time. Trade with coastal groups was common. The phase includes contracting-stemmed projectile points and triangular basal or corner-notched projectile point types.
4500-2500	**Middle Prehistoric Period**	**Frenchman Springs Phase.** Introduction of semi-subterranean houses and more specialized camps for hunting, root collecting, and plant processing. Several styles of contracting-stemmed points predominate. Many have argued that the ethnographically-observed “Plateau Culture” had emerged by the end of the phase. Diagnostic projectile points include leaf-shaped points, broad-stemmed points with rounded shoulders, and triangular points with concave, expanding bases.
8000-4500	**Middle Prehistoric Period** / **Early Prehistoric Period**	**Vantage Phase.** Inhabitants were highly mobile, opportunistic foragers adapted mainly to riverine environments. Increasing reliance on fish with less use of game. Sites are located along stream margins and points are similar to those of the Windust Phase. Leaf-shaped (Cascade) and large (Cold Spring) side-notched projectile point types used, likely as atlatl tips.
10,500-8000	**Early Prehistoric Period**	**Windust Phase.** Characterized by small, highly mobile bands of foragers/collectors who exploited plant and animal resources using a seasonal settlement system. Sites are generally small and exhibit low artifact densities. Diagnostic of the phase are large, shouldered or basal notched lanceolate projectile points.
12,000-10,500		**Clovis.** Characterized by small, highly mobile bands of hunter/gatherers that exploited a wide range of subsistence resources, including bison and elk. Sites are usually small, exhibit low artifact densities, and are associated with older landforms, especially upland plateaus. Large lanceolate, fluted projectile points (Clovis points) are diagnostic.

Source: Chatters 1989; Galm et al. 1987; Lothson 1982
[1] Before Present

TABLE 3-18. CHRONOLOGICAL SEQUENCE FOR THE LOWER OKANOGAN VALLEY REGION

YEARS BP[1]	DESCRIPTION OF CULTURE HISTORICAL PLACES
c. 1,000 - present	Cassimer Bar. Introduction of Euroamerican technology and non-indigenous diseases lead to culture change and significant population collapse for Native American groups. Increase in seasonal mobility and a shift to portable mat houses. People dispersed to gather roots in the spring and to hunt in the fall and winter. This seasonal round became increasingly diverse and well organized over time. Trade with coastal groups was common. The phase includes smaller triangular square shouldered with low corner notches and triangular basal-notched projectile point types (Columbia Corner Notched, Columbia Stemmed).
c.3,000-c.1,000	Chiliwist. More specialized camps for hunting, fishing, root collecting, and plant processing. Several styles of contracting-stemmed points predominate. Change from small dispersed winter pithouse habitation to aggregation into winter villages during this phase. Diagnostic projectile points include triangular slightly shouldered contracting-stemmed points, and triangular points with square shoulders and straight-to-slightly-contracting stems (Nespelem Bar, Rabbit Island Stemmed).
c.4,700-c.3,000	Indian Dan. Introduction of semi-subterranean houses. Inhabitants were highly mobile, opportunistic foragers adapted mainly to riverine environments. Increasing reliance on fish with less use of game. Camps and single pithouses are located along stream margins on upper terraces. Projectile points are large, shouldered or unnotched lanceolates (Mahkin Shouldered, Cascade).
8,000-c.4,700	Okanogan. Characterized by small, highly mobile bands of foragers/collectors who exploited plant and animal resources using a seasonal settlement system. Sites are generally small and exhibit low artifact densities. Diagnostic of the phase are large basal notched lanceolate projectile (Cascade) points.
11,000-8,000	Clovis. Characterized by small, highly mobile bands of hunter/gatherers that exploited a wide range of subsistence resources, including bison and elk. Sites are usually small, exhibit low artifact densities, and are associated with early landforms, especially upland plateaus. Large lanceolate, fluted projectile points (Clovis points) are diagnostic.

Source: Chatters 1986; Grabert 1968a; Hollenbeck and Carter 1986
[1] Before Present

olivella shells indicate that trade took place, at least indirectly, between the Pacific coast and the Columbia River basin.

Sites and isolated projectile points dating to this period are located within river basins and at the confluence of major rivers. Faunal assemblages at these sites indicate that opportunistic hunting was restricted to a narrow range of vertebrate species. Among these species, deer and rabbit predominate followed by coyote and birds. Aquatic species, however, are found in much greater frequencies than terrestrial species, suggesting an increased focus on riverine resources as the climate warmed. Overall, the remains of fresh-water mussels predominate, followed by salmon, sturgeon, or trout remains (Chatters 1989; Galm et al. 1987; Hollenbeck and Carter 1986; Lothson 1982).

Between 4700 and 4500 years BP, an increase in precipitation in the region significantly altered the nature and distribution of land use during this period. Non-riverine environments gradually became more productive leading to more diversely structured micro-environments affecting local adaptations. In addition to open sites and rockshelters, riverine and some non-riverine environments contain pithouses. Some inhabitants were probably sedentary foragers living in widely dispersed pithouses, strategically located in game wintering areas, while others, especially along the Mid-Columbia River, maintained a mobile, opportunistic foraging adaptation. Except for a hiatus between 3800 and 3400 years BP, pithouses become more frequent throughout the period.

Toward the end of the period, non-pithouse sites are believed to reflect functionally distinct habitations including hunting camps, shell-fish processing camps, fishing camps, and plant-processing camps. Inhabitants of the region structured mobility around the availability of annual resources. Along with evidence of an increase in the use of seasonally available resources, archaeologists noted an increase in the evidence of food storage technology. Storage pits found in pithouse and rockshelter floors often contain the remains of salmon, deer, roots, and fresh-water mussels (Chatters 1989; Galm et al. 1987; Hollenbeck and Carter 1986; Lothson 1982).

A return to drier conditions by 2300 to 2200 years BP affected the nature and distribution of land use. As resource productivity and diversity decreased, resources became concentrated into fewer productive patches. Archaeological evidence indicates:

- intensification of resource collection within these more patchy micro-environments; and
- an increase in travel time between resources.

Researchers have noted the wide distribution of villages of 10 to 200 pithouses on the middle and upper Columbia River. Common artifacts of this period include narrow contracting-stemmed projectile points and triangular basal- or corner-notched points, stone bowls, elongated pestles, self-handled mauls, nephrite adze blades, tubular stone pipes, beads of clam, olivella and dentalium shell, pendants of abalone shell, and anthropomorphic and zoomorphic rock carvings. In the winter, people inhabited pithouse clusters, often in defensible locations. In the spring they dispersed into small foraging groups inhabiting temporary root camps or fishing camps. Fishing was a mainstay in the summer and fall months. People stored fish, large game, and root crops for consumption during the winter months when small groups aggregated into large villages (Chatters 1989; Galm et al. 1987; Hollenbeck and Carter 1986; Lothson 1982).

3.9.1.1 Wells Dam Area

G. F. Grabert (1968a) conducted salvage excavations in the Wells reservoir in the late 1960s. He noted that sites occur along much of the shoreline, with the exception of the right bank between Brewster and the mouth of the Okanogan River and the left bank between Brewster and Bridgeport. The majority of the recorded sites are small procurement camps, although pithouse villages occur near the mouth of the Okanogan River (Grabert 1968a).

Salvage excavations conducted by Chatters in the reservoir area during the early 1980s further refined Grabert's cultural phases, as shown in Table 3-18 (Chatters 1986; Grabert 1968a). Chatters excavated 13 sites with 28 structures situated on two terraces just above the reservoir. These sites yielded radiocarbon dates ranging between 360 and 7,730 BP, which indicated that large pithouses appeared after 4,040 BP (Chatters 1986).

Prehistoric use of the environments in the Wells Dam area could have resulted in sites similar to those described for the Rock Island and Rocky Reach dams.

3.9.1.2 Rocky Reach Dam Area

During the late 1950s, Washington State University surveyed the inundation area for the proposed Rocky Reach Dam reservoir and selected several sites for salvage excavation. These early investigations recorded pithouses, hunting/fishing/gathering camps, and river mussel shell middens (Gunkel 1961).

In 1983, Washington State University updated these studies and corroborated an earlier conclusion: the Rocky Reach reservoir area lacks village sites, which characterize moderately large population aggregations along the Columbia River up- and downstream from this area. Although radiocarbon dates ranging from 8,200 to 1,000 BP suggest long-term use of the area, the scarcity of village locations is problematic. The researchers also note that this stretch of the river does not have easily accessible fisheries locations such as rapids, falls, and tributary mouths, but its steep canyon walls offer prime habitat for deer, elk, and bighorn sheep; a rock alignment, which is adjacent to river margin terrace, may have been used as a hunting blind or drive line for these animals. Schalk and Mierendorf note that the Rocky Reach area may have supported temporary hunting camps for groups that resided outside of the area, or that people who adapted to a highly-mobile hunting strategy lived in the narrow valley for most of the year (Schalk and Mierendorf 1983).

As part of a proposed pool elevation raise, Chelan County PUD requested that Eastern Washington University resurvey the reservoir margin in 1990. Eastern Washington University's results reconfirmed Schalk and Mierendorf's previous findings. The 1990 study suggests that residential sites:

- may exist on level landforms outside of the project area;
- may have formerly been located on the developed terraces above the reach; or
- may be deeply buried (Boreson 1992; Galm 1990).

Prehistoric use of the environments in the Rocky Reach Dam area could have resulted in sites similar to those described for the Rock Island Dam area. However, the probability for discovering village sites within the Rocky Reach segment appears to be lower than in other sections of the project area.

3.9.1.3 Rock Island Dam Area

Washington State University published a comprehensive report based on its reservoir-wide survey and testing program for the Rock Island Dam hydroelectric project in 1982, and Eastern Washington University produced a management plan for the reservoir in 1988 (Lothson 1982; Galm and Masten 1988). Prehistoric sites within the Rock Island reservoir located north of the Wenatchee highway bridge (State Route 285) are situated on low terraces that extend up to 1 mile from the river. Sites in this area include both temporary resource procurement camps and permanent village locations, and the majority of them cluster around the confluence of the Columbia and Wenatchee rivers. Small shellfish gathering sites occur on the downstream side of alluvial fans, such as at the base of the Rock Island Dam and north of the Wenatchee Flats. The Rock Island rapids area was also an important bighorn sheep hunting area (Lothson 1982).

The area of the reservoir above the dam and south of the Wenatchee highway bridge is located along a more constricted segment of the river, and much of the steeply-sloping sides of the canyon lie beneath 6 to 18 meters of water. Five large sites, which archaeologists suggest were summer and fall fishing camps, occupied both prehistorically and ethnohistorically, lie near the dam, which was formerly the Rock Island rapids (Lothson 1982).

Based on analysis of sediments and stratigraphy in the reservoir area, archaeological sites in the Rock Island Dam study area do not pre-date 13,500 BP. Cascade type projectile points and radiocarbon dates recovered directly from the sites around the reservoir place the earliest datable prehistoric occupation just prior to 3,000 BP. Diagnostic artifacts and radiocarbon dates obtained from various locations around the reservoir suggest continual occupation into the late prehistoric period. Researchers propose that prehistoric peoples living in the Rock Island Dam area used the winter village settlement pattern by 4,500 BP and long mat lodges by 1,100 BP (Galm and Masten 1985, 1988; Lothson 1982).

Prehistoric use of the environments in the Rock Island Dam area could have resulted in domestic archaeological sites, such as villages and camps, along with resource procurement and processing stations for fish, mammals, birds, and edible and utilitarian plants, as well as lithic and mineral raw materials. In addition, trails could connect these places, and burials could occur throughout the project area. Prehistoric use could have resulted in isolated remains that could include projectile points and other artifacts or features such as cache pits, fire hearths, or petroglyphs. These sites provide information regarding settlement and subsistence strategies.

3.9.1.4 Associated Tributaries

The major tributaries that flow into the Columbia River near the Wells, Rocky Reach, and Rock Island reservoirs include the Wenatchee, Entiat, Methow, and Okanogan rivers. Prehistoric use of the environments in these tributary basins could have resulted in sites similar to those described for the Wells, Rocky Reach, and Rock Island dams, possibly with a greater emphasis on smaller, short-term resource procurement sites.

3.9.1.5 Columbia River System

The Columbia River has served as a focal point for prehistoric settlement and subsistence patterns throughout the plateau's prehistory. A wide variety of wildlife, including deer, elk, sheep, migratory waterfowl, and resident and anadromous fish are part of an abundant resource base that relies on the riparian and aquatic environments of the Columbia basin. Prehistoric peoples residing in this region focused their subsistence strategies on these environments to procure food and technological resources. Prehistoric archaeological resources in the project area fit the general pattern seen throughout the Columbia River system area.

3.9.2 HISTORICAL RESOURCES

The following paragraphs provide a general historical context for the Wells, Rocky Reach, and Rock Island dam areas of the Columbia basin. The subsections that follow contain information specific to each of the reservoir areas and the major tributary basins adjacent to these reservoirs.

The earliest effects of Euroamerican contact appeared in Columbia River native communities before the Euroamericans themselves. Although researchers have not yet determined when epidemic diseases first emerged, some (e.g., Campbell 1989) have suggested that waves of epidemics may have started prior to direct contact. Epidemics of various diseases continued to decrease populations to differing extents. Columbia River Indian groups lost a majority of their population to introduced diseases, such as smallpox, cholera, typhus, chickenpox, or measles, and the health of the survivors was reduced (Boyd 1985; Cook 1955; French 1961). Population estimates for the Okanogan (Sinkaietk), Methow, Isle de Pierre (Rock Island Sinkuse), and Wenatchee Indians prior to the epidemics of the late eighteenth century are 3,200. After disease spread through the area, the combined figure for these groups and the Sahaptin-speakers along the Mid-Columbia River was estimated at 2,674 (Mooney 1928).

The first Euroamerican exploration of the Columbia basin region was most likely Lewis and Clark's expedition, which traveled through the area of the Snake and Columbia rivers in 1805 to 1806. Soon after Lewis and Clark returned to St. Louis, Missouri, fur trappers moved into the northern Columbia basin region and built Fort Okanogan (Johansen and Gates 1967; Meinig 1968).

In the 1850s, warfare erupted with the interior Native American Tribes, under pressure from an influx of white miners, cattlemen, and settlers. Washington's territorial governor, Isaac I. Stevens, attempted to end these bitter conflicts by holding a council at Walla Walla in 1855. The Indians in attendance ceded the majority of their territory in return for the establishment of lands reserved for the exclusive use of tribal members. In 1872, Ulysses S. Grant established the Colville Reservation for members of the Colville, Entiat, Methow, Nespelem, Nez Perce, Sinkaietk, Palouse, Sanpoil, Senijextee, Sinkiuse, and Wenatchee Tribes (Ruby and Brown 1986). But the treaties did not eliminate trouble and growing pressure from whites resulted in a series of short, bloody battles.

After 3 years of skirmishing, the U.S. Army increased its presence in the area and compelled the Native Americans to reaffirm the Stevens treaties. The lasting result of this period of upheaval was a slowing of settlement east of the Cascades. It was not until the early 1870s that permanent settlements began to increase in the Columbia basin. On a trip across the Washington Territory, Governor Stevens called the region “the Great Plains of the Columbia” and maintained it would support a farming population (Johansen and Gates 1967; Meinig 1968).

Before any farming could commence, settlers had to decide how this area of sagebrush and rolling hills could be cultivated. Early cattlemen had overgrazed the free lands, with little concern for the consequences. Farmers arriving in the region, in response to railroad promises of inexpensive land, realized dry land farming was the only method that could be employed. The topography of the region lends itself to growing crops on a grand scale. Wheat was the crop of choice for two reasons: wheat was a dry land crop and, to be profitable, it had to be cultivated in huge quantities. Both of these conditions existed in the Columbia basin. Wheat flourished in this limited-moisture environment (Johansen and Gates 1967; Meinig 1968).

Settlers interacted in ways with the Indians that led to changes in their culture. Alcohol, disease, and dislocation disrupted social and political organization. Euroamericans also often hired Indians to act as guides, portagers, as transporters of goods and messages, and to cut timber, and tend herds and crops, all of which took native people away from their traditional subsistence-oriented activities. Euroamericans introduced hay, tobacco, and garden crops into the Columbia basin by 1860, and researchers speculate that enforced sedentism may have caused Columbia River Indians to adopt agriculture in favor of seasonal root gathering (Boyd 1985; French 1961; Ruby and Brown 1986).

Railroads, which did not service this region until the late 1880s, encouraged wheat growing. Wheat farming communities created demands for inbound consumer goods and farming machinery. Railroads changed the economic picture for local grain growers by shipping wheat at lower prices. At the same time, they guaranteed themselves steady employment for their rail cars. Prior to this time, the cost of transporting a bushel of wheat to England via ship proved less expensive than sending it to American millers (Johansen and Gates 1967; Meinig 1968).

Storage facilities for the harvested winter wheat grew in numbers as the crops increased in volume. Initially, one-floor warehouses were able to accommodate smaller volumes of sacked grain, but later, grain elevators were used to store winter wheat in bulk quantities for shipment by barges on the Columbia River. Barge shipment on the Columbia River replaced railroad cars as the primary means of transporting grain out of the Columbia basin. No agricultural commodity in the State ranked higher than wheat. By 1910, it represented 44 percent of the total value of Washington crops. Wheat was not the only crop grown in the region. Irrigation allowed farmers to broaden their agricultural horizons. The first major irrigation project in the Columbia basin was a private venture called the Sunnyside Canal, which began operating in 1892 (Kirk and Alexander 1990; Meinig 1968; Schwantes 1996).

By the early twentieth century, promoters had recognized the importance of government involvement in irrigation projects. Accordingly, the Federal government acquired area irrigation projects, which became part of a larger effort by the U.S. Reclamation Service. Completion of numerous irrigation projects brought to an end the struggle, started in the early twentieth century, of individual farmers or loosely-knit private consortiums to bring water to the parched acres of land in the region. Farmers used the irrigation canals to water hay, apples, cherries, peaches, pears, berries, grapes, peas, beans, and potatoes (Johansen and Gates 1967; Meinig 1968).

As population in the State increased, the demand for beef increased proportionally. Livestock raising became more profitable because railroads could satisfy this demand more efficiently. In the 1870s and early 1880s, most cattle raised in the basin were either driven long distances on foot through Snoqualmie Pass or shipped down the Columbia River on boats. Later, ranchers moved cattle to Seattle or Midwestern markets via the railroad. Rail connections with the Northern Pacific Railroad allowed cattlemen to ship their cattle direct to market without the losses incurred during long drives (Johansen and Gates 1967; Holstine 1994; Meinig 1968).

The massive amounts of electrical power produced by early hydroelectric plants influenced the region in another manner. During World War II, the available electrical power made possible rapid expansion of the wartime and post-war economy. Aluminum for airplanes, sub-assemblies for destroyers, and castings for the Seattle shipyards were produced in the region. Population in the region swelled as more industrial output was required and more jobs were created. The availability of inexpensive electrical power continued to draw businesses to the region (Johansen and Gates 1967).

3.9.2.1 Wells Dam Area

David Stuart and David Thompson, representing the American Pacific Fur Company, established Fort Okanogan at the confluence of the Columbia and Okanogan rivers in 1811. After the War of 1812, the fort briefly belonged to the Canadian Northwest Company, which later merged with the Hudson's Bay Company. During this period, the fort served as the gateway to other outposts further north. The Hudson’s Bay Company abandoned the fort in 1860 after the public's demand for beaver furs waned. G. F. Grabert excavated this site as part of his salvage work for the Wells reservoir. His findings confirmed the locations of warehouses, blacksmithing sheds, and the Main House. In addition, Grabert noted that the occupants subsisted primarily on a diet of horse meat, augmented with deer and salmon. Grabert concluded that the abandonment of the fort was planned and orderly, due to the apparent removal of structures and useable lumber and hardware from the site, and a lack of complete artifacts. Indians returned to the area after the Hudson’s Bay Company left, superimposing hearths and stone flake debris over several segments of the Euroamerican debris (French 1969; Grabert 1968b; Meinig 1968; Mitchell 1968).

During the historic period, the Wells reservoir area was part of the Methow and Sinkaietk Indian territories. Methow people, whose ancestral lands lay within the Moses, or Columbia reservation accepted allotments in this area. Others followed Chief Moses to the Colville Reservation in the 1870s. The southern extent of Sinkaietk territory is located at the confluence of the Columbia and Okanogan rivers. The Sinkaietk, whose name means “people of the water that does not freeze,” are closely related to the Methow people living just downstream along the Columbia. This group did not participate in the Walla Walla treaty council, nor did they follow Moses, whose reservation was established in their ancestral lands. The Sinkaietk remained in their homeland after the Moses Reservation was established and then terminated in 1884. Today the Tribe is part of the Confederated Tribes of the Colville Reservation (Ray 1936; Ray 1974; Ruby and Brown 1986).

Beginning in the late 1880s, settlers entered the area and established homesteads. The pioneers found fertile soil, but poor transportation facilities. Riverboat service aboard the City of Ellensburg between Brewster and Wenatchee was sporadic due to high or low water levels or ice (Kirk and Alexander 1990; Meinig 1968).

In the mid-1910s, Alfred Z. Wells established an orchard and company town below the modern location of Wells Dam. The town, now named Azwell, still serves as a fruit packing and shipping center. Further upstream, Pateros is also an orchard center, which grew as a result of its rail link to

Wenatchee. The town was originally located in a narrow stretch of the Columbia, but the rise of Lake Pateros behind the Wells Dam in 1967 forced it and the railroad to relocate onto a higher terrace (Dorpat and McCoy 1998; Kirk and Alexander 1990; Ramsey 1973).

Historic period use of the environments in the Wells Dam area could have resulted in sites similar to those described for the Rock Island and Rocky Reach dams.

3.9.2.2 Rocky Reach Dam Area

Within the Rocky Reach Dam area, the Wenatchee, Sinkiuse, Entiat, and Chelan Indians occupied the banks of the Columbia River between the mouths of Swaukane and Antoine creeks. The Entiat Indian territory, which may have overlapped that of the Wenatchees, centered around the confluence of the Entiat and Columbia rivers. Further upstream, the Chelan Indians settled around Lake Chelan or moved to the Colville Reservation after the 1855 treaty negotiations. The Chelan people were the subject of intensive missionary efforts by Roman Catholic priests who used the unusual earthquake of 1872, which blocked the flow of the Columbia for a day, to covert the Indians to Christianity (Ruby and Brown 1986).

Cattle ranchers settled in the foothills above the Entiat valley by 1860. After summer grazing ended, ranchers herded cattle and sheep from the mountains to stock boat moorings or railcars, creating wide drive line trails along the Columbia. A cattle ranch at the mouth of the Entiat River continued operating as late as 1907 (Holstine 1994).

In the mid-1860s, Chinese miners, migrating from the Californian and British Colombian gold fields, excavated a ditch adjacent to the Entiat River, near its confluence with the Columbia, where they placer mined for gold. The Chinese occupied a village along the Columbia across from the mouth of the Chelan River. After mining activities slowed in the area, timber harvests in the foothills increased, creating the need for sawmills in the area. Charles A. Harris constructed the Entiat Mill in 1892. Construction crews for the Rock Island Bridge used timbers floated down the Columbia from this mill. Local farmers also shipped grain down the Columbia. A tram at Orondo hauled grain from the upper terrace of the plateau down to the water. Shippers used the tram from 1902 until 1909, when a branch line of the Great Northern Railroad reached the town of Douglas (Holstine 1994; Hull 1929; Kirk and Alexander 1990; Meinig 1968; Western Historical Publishing Co. 1904a).

In the fall of 1872, an earthquake collapsed a segment of a cliff face, located about 2 miles north of Entiat, into the Columbia River. The river was dammed for several hours, until it broke loose in a "column fifteen feet high." The spot along the Ribbon Cliffs is known today as "Earthquake Point" (Western Historical Publishing Co. 1904b).

As early as 1904, civic planners in Orondo projected use of hydroelectric power to run the roller in their flour mill. Charles A. Harris constructed one of the first power plants in the area for the Entiat Light and Power Company by 1908. Rocky Reach Dam was one of five hydroelectric power plants erected during the late 1950s and early 1960s on the Columbia. (Dorpat and McCoy 1998; Hull 1929; Kirk and Alexander 1990; Western Historical Publishing Co. 1904a).

Historic period use of the environments in the Rocky Reach Dam area could have resulted in sites similar to those described for the Rock Island Dam area.

3.9.2.3 Rock Island Dam Area

Within the Rock Island Dam area, the Sinkiuse and Wenatchee occupied the banks of the Columbia River around Rock Island and the mouth of the Wenatchee River. David Thompson and other fur traders from the North West Fur Company arrived in the Wenatchee valley by 1811, portaging past the Rock Island rapids on July 7th.

Indian-Euroamerican relationships in the area deteriorated in the late 1850s when miners murdered the Sinkiuse leader's son. Leadership of the Tribe and other non-treaty Mid-Columbia River Indians passed to Chief Moses. Moses and his followers never occupied the Columbia Reservation (also known as the Moses Reservation) that the U.S. Government set aside for them in 1879. The lands returned to public domain, and Moses and his band moved to the Colville Reservation (Ruby and Brown 1986).

Chief Tecolekun signed the treaty at Walla Walla, but was killed during skirmishes with the U.S. Army in 1858. The Yakima Treaty grouped the Wenatchees with the Yakama because of their association at the Wenatschapam fishing site. This fishery was sold, at the urging of the Yakima agent, to fund an irrigation project on the Yakama Reservation. Beginning in 1911, Wenatchee people began moving to allotments on the Colville Reservation (Ruby and Brown 1986).

By 1860, the trappers populating the valley had been replaced by Euroamerican and Chinese placer miners. The miners worked claims along the sand and gravel banks and bars of the Columbia and its tributaries, including Chinaman Flat near Malaga. Wenatchee became a trading post for early settlers and miners and was incorporated in 1888. That same year, the first steamboat, the City of Ellensburg, traveled up the Columbia from Pasco to Brewster and used four guy lines to sail past Rock Island.

The Great Northern Railroad entered the region in 1892, which prompted the city to move closer to this new transportation route and to the Columbia River. One year later, the railroad built the Rock Island Bridge, which, along with the Columbia River Bridge located further upstream, is now listed in the National Register of Historic Places. Rock Island Dam was the first hydroelectric project on the Columbia River. Puget Sound Power and Light Company constructed the dam between 1929 and 1933, and its innovative design included three fishladders (Dorpat and McCoy 1998; Holstine 1994; Hull 1929; Kirk and Alexander 1990; Mitchell 1968; Thomas 1975; Tyrell 1916; Writers' Program 1941).

Historic occupation or activities in the Rock Island Dam area could have left a variety of remains, including buildings, structures, sites, and discarded equipment and other artifacts that reflect many types of use. Euroamerican exploration, trade with Indian people, and military activities associated with the Indian uprising of 1855 and 1856 left camp and fort sites. Settlement and farming sites may include cabins, homesteads, farms and ranches, corrals, towns, and school and commercial buildings.

The development of water resources throughout the Columbia basin for transporting goods, producing electricity, irrigating farmlands, and domestic use could result in such remains as wells, spring boxes, water wheels, flumes, irrigation ditches, pipes, power lines, and poles. Transportation has been particularly important to the culture history of the Columbia River basin. Artifacts and features associated with Indian and explorer trails, wagon roads, and railroads, including rail and road grade segments, bridges and trestles, tunnels, construction camps, dumps, rail cars, and equipment could exist in the project area. Ethnohistoric sites could be similar to the prehistoric sites described for the Rock Island Dam, with the addition of items of Euroamerican origin. Ethnohistoric use could have resulted in isolated remains that could include projectile points and other artifacts or features such as cache pits, fire hearths, or petroglyphs.

3.9.2.4 Associated Tributaries

Tributary drainages flowing into the Columbia River served as important fishery, hunting, and gathering sites beginning in the prehistoric period and continuing into ethnohistoric times. Miners staked claims in the foothills of the Cascades east of the Columbia River and in the hills surrounding the Okanogan River valley beginning in the 1860s. As the prospects for mining waned in these areas, timber cutting opportunities increased, which continue into the present. Settlers built the first trading post near the mouth of the Wenatchee River. The Wenatchee Flat site, which is actually comprised of several archaeological sites, served as a crossroads and meeting place for Native and Euroamerican peoples. This site is now listed in the National Register (Brown and Wilson 1971).

Historic-period Euroamerican use of the environments in the Wenatchee, Entiat, Methow, and Okanogan River drainage areas could have resulted in sites similar to those described for the Wells, Rocky Reach, and Rock Island dams, with a greater potential for mining and logging camp remains in these areas. Ethnohistoric sites could be similar to the prehistoric sites described for the three dam areas, with the addition of items of Euroamerican origin. Ethnohistoric use could have resulted in isolated remains that could include projectile points and other artifacts or features such as cache pits, fire hearths, or petroglyphs.

3.9.2.5 Columbia River System

During the historic period, the Columbia River figured prominently in the first direct contact between Native peoples living in the Columbia basin and Euroamericans. Traders, trappers, and, later, homesteaders followed the Columbia's route to settle in the interior plateau. The river not only contributed food resources to the occupants of the area, but also provided a means of transportation. Later, irrigation systems and hydroelectric power plants constructed along the Columbia brought change to the agricultural and industrial sectors of the region. Historic period archaeological sites, buildings, and structures within the project area fit within the greater pattern of historical resources seen throughout the Columbia River system drainage area.

3.9.3 INDIAN TRADITIONAL CULTURAL PLACES AND RESOURCES

Indian groups generally are concerned about development that occurs within their aboriginal territories. Federally recognized Tribes are concerned about their treaty rights, and the various tribal groups often want to protect traditional cultural properties which include cultural heritage and traditional religious sites, as well as traditionally-used natural resources that occur in geographically-limited locations. In addition, Indians consider the natural landscape, and individual elements that comprise it, as spiritually sacred; these include, but are not limited to: cultural sites (archaeological and rock art/feature sites), fisheries, cultural plants, and wildlife. The following paragraphs provide a general ethnohistorical context for the Wells, Rocky Reach, and Rock Island dam areas of the Columbia basin; the subsistence practices described below in the tribal ancestral lands form an integral part of traditional lifeways for these groups (Hanes 1995). The subsections that follow contain information more specific to each of the reservoir areas.

At the time of Euroamerican contact, the Interior Salishan-speaking Sinkiuse, Wenatchee, Chelan, Methow, Entiat, and Sinkaietk Indian groups resided along the Columbia River. These Columbia River Indian groups visited a number of environmental settings during the year's subsistence activities. These people employed various technologies to harvest each resource at the time and place it was available. Both men and women conducted the yearly subsistence work of fishing, gathering, and hunting resources that were consumed fresh and processed for winter storage. Recent work (e.g., Hunn 1990) on the land use of the Indians of the Mid-Columbia River has supplied many details, particularly on the use of plants. Certain ceremonial activities accompanied the yearly harvests especially as the groups welcomed and gave thanks to each of the major food groups of salmon, roots, berries, and others.

Early spring activities began with root collecting as family groups left their winter settlements and camped near root digging grounds. Women used digging sticks and woven bags to collect roots and pack them back to their camps for baking in earth ovens and drying for use as winter supplies. While many roots are sparsely distributed, camas sometimes is concentrated in great meadows where large numbers of people could gather during the harvest season for work and socializing. Family groups carried the dried roots back to the winter settlements and buried them in below-ground caches before they set out again to collect more resources.

Groups then gathered at productive fishing stations along rivers when the spring salmon runs began. The men fished while the women cleaned and dried the fish. As the catch dwindled, the groups again stored their supplies and left in later May to dig a variety of roots including bitterroot, camas, kaus, lupine, wild carrot, onion, and others, establishing camp sites and moving them as the harvest progressed. Groups with access to streams where lamprey eels, suckers, whitefish, and sturgeon ran interrupted their root digging to net or spear these fish (Hunn 1990; Ray 1932; Spier and Sapir 1930; Teit 1928).

Salmon and steelhead runs appeared in the rivers during summer, drawing the groups to return the new root surpluses to their winter caches and harvest the fish. Men pursued their traditional role of fishing and women cleaned and dried the catch. Between fish runs, women gathered and dried berries, including golden currant, gooseberry, dogwood, serviceberry, cranberry, huckleberry, blackberry, and chokecherry (Hunn 1990; Ray 1932).

Beginning in August, Columbia River Indian groups moved into the mountains where they camped through the early fall to harvest and smoke-dry several species of huckleberries. While the women picked and harvested berries, nuts, and moss, men hunted deer, elk, bear, cougar, wolf, and fox in the mountains. The groups likely split at times to allow some to return to the rivers in early September to harvest the fall-run chinook salmon run which provided much of the winter supply. They made a kind of pemmican from pounded salmon and dried berries, mixed with salmon oil. In October, people moved back to their winter settlements, processing the dying salmon of the fall-run chinook salmon run (French 1961; Hunn 1990; Ray 1932; Spier and Sapir 1930).

Columbia River groups maintained permanent winter settlements along protected tributaries to the Columbia and other rivers. Living in semisubterranean houses, mat lodges, or other types of substantial structures, extended families used the winter months to make and repair tools, baskets, clothing, and other necessary items. They visited other groups, conducted religious and social ceremonies, exchanged information and food surpluses, and repeated the stories of their mythology that instructed children about how to make their living and how to treat other people. Burials of various types were associated primarily with the winter settlements (Hunn 1990).

3.9.3.1 Project Area

Wells Dam Area

Ethnographers list Tkuyatum, located at the mouth of the Okanogan River, about 3 miles upstream from Brewster, and Xantcin, or "little rocky gate," just south of Pateros, as Sinkaietk villages (Ray 1936; Ray 1974; Ruby and Brown 1986).

Rocky Reach Dam Area

Principal Wenatchee villages located in the Rocky Reach study area include Patlkinulu, located on the west bank of the Columbia, 8 miles north of the Wenatchee River; and Ntiatku, meaning "weedy river," at the present site of Entiat. The latter village was jointly used by the Wenatchee and Chelan Indians. Additional villages of the Chelan people included Niyalqen, or "basin in which the creek meanders", north of Winesap at the confluence of Maple Creek and the Columbia River, Nairrp on the west side of the Columbia between Beebe and Bonita, and an unnamed village at the mouth of Antoine Creek. Cwaxtinten, meaning "barking dog," was located near the mouth of Byrd Canyon about 6 miles north of Entiat, and Swaxtciltan, or "horse haven," was situated on a bench above the Columbia River near Tenas George Canyon south of Wagnersburg. A camp called Xaxa'tqu, meaning "dragon jaws," was located one mile downstream from Wagnersburg on the east side of the Columbia (Ray 1936; Ray 1974).

Rock Island Dam Area

Ethnographers have identified several Indian place names near the Rock Island project area. A permanent village, Tapiskin or Nqolaqom, was located below the dam near the mouth of Colockum Creek. Two villages, Skilkatin and Skwietaktcin, were located near Stemilt and Squillichuck creeks south of Wenatchee. Nikwikwiestku, "purplish rock," and Skwiltaktcin, "two owls," were located south of the modern Wenatchee business district. These sites were a small summer camp and a summer fishing and gathering village, respectively. The largest of the Sinkiuse villages, Kawaxtcin, meaning "living on the banks (river's edge)," was located at the mouth of Rock Island Creek. A Wenatchee camp named Pat'l'kinu'lu was located near Zena, 8 miles north of the mouth of the Wenatchee River. The villages Stchopas and Kultaktcin, "delta," were situated near the mouth of the Wenatchee River (Ray 1936; Ray 1974).

3.9.3.2 Tributaries

A Wenatchee village named Alota's, which housed about 200 people, was located on the north bank of the Wenatchee River, about half a mile downstream from Monitor. Further north, where Leavenworth is currently located at the mouth of Icicle Creek, the village Tcamaus or "narrow in the middle" served as the principal Wenatchee fishing site. Almost 200 people occupied this village during the summer, but visitors swelled the population to 2,000 to 3,000 during salmon and steelhead runs. The largest Wenatchee village, Ntua'tckam, was located where the town of Cashmere is presently. This permanent village housed 400 residents throughout the year (Ray 1936).

3.9.3.3 Columbia River System

Indian groups generally are concerned about "the totality of the regional landscape," in which "all landscape components participate in a system of complex inter-relationships" (Hanes 1995). Indians consider the natural landscape, which includes cultural sites, fisheries, cultural plants, and wildlife, as sacred. The subsistence practices described in the paragraphs above take place in tribal ancestral lands that form an integral part of traditional lifeways for these groups (Hanes 1995). The project area is part of sacred lands whose landscape and features "serve as constant reminders of (the Native people's) spiritual identity" (Hanes 1995).

Throughout the millennia, salmon and steelhead have played an important role in culture of Native American Tribes along the Columbia River (Hanes 1995). During pre-contact times, Tribes established fishing sites where they regularly harvested salmon. In 1969, the supreme court decision *U.S. vs Oregon* established that the 1855 treaties of the Yakama, Warm Springs, Umatilla, and Nez Perce Tribes had reserved for these Tribes the right to fish at all "usual and accustomed" places on or off their reservations. The court later decided that the Columbia River Tribes were entitled to 50 percent of all harvestable fish destined for the traditional fishing places. In 1974, the *U.S. vs Washington* court case, which addressed the fishing rights of Puget Sound Tribes, determined that for the purposes of measuring harvestable fish there is no difference between hatchery and native salmon. These court decisions interpreting the Tribes' treaty-reserved fishing rights are the legal framework supporting the Native American traditional practice of harvesting salmon and steelhead along the Columbia River.

3.9.4 Cultural Resources License Requirements

3.9.4.1 Wells Dam and the Management of Cultural Resources

The license under which the Wells Dam is currently operating was issued on July 12, 1962 and amended on September 23, 1982. The original license was issued prior to the 1966 enactment of Section 106 of the Historic Preservation Act, which requires that projects including Federal involvement consider impacts to historic resources that qualify for listing in the National Register. Consequently, the original license included few measures to protect cultural resources. The cultural resource considerations listed in the original license occur in article 44, which prescribed the following measures be taken to protect cultural resources:

> The Licensee shall cooperate with the Secretary of the Interior in the preparation of a public use plan for the area and in the possible salvage of the archaeological data and shall, upon written request of the Commission, make available to the Secretary, or to a qualified agency designated by the Secretary, reasonable amounts of monies not to exceed a total of $10,000 in the preparation of a public use plan and not to exceed a total of $55,000 to compensate for expenses incurred in archaeological investigations in the pool area.

When the Wells license was amended on September 23, 1982, to address the effects of raising the pool level approximately 2 feet, cultural resource issues were more thoroughly considered (FERC 1982). Under the amended license, the PUD determined that 13 archaeological sites within the affected area were eligible for the National Register. To mitigate for the inundation of these sites, the State Historic Preservation Officer required that data recovery be conducted at the sites before the pool level was raised. These excavations occurred in 1983 and 1984 (Chatters 1986:iii).

3.9.4.2 Rocky Reach Dam and the Management of Cultural Resources

The Rocky Reach Dam is currently operating under a license that was issued on July 11, 1957. The cultural resource considerations in the license occur in Article 37 and are the same as those listed in the Wells Dam license Article 44. In March 1983 Article 49 was added to the license. This article prescribe the following measures:

> The Licensee shall, prior to the commencement of any construction at the project, consult with the Washington State Historic Preservation Officer (SHPO) about the need for any cultural resource survey and salvage work. The licensee shall make available funds in a reasonable amount for any such work as required. If any previously unrecorded archaeological or historical sites are discovered during the course of construction or development of any project works or other facilities at the project, construction activity in the vicinity shall be halted, a qualified archaeologist shall be consulted to determine the significance of the sites, and the licensee shall consult with the SHPO to develop a mitigation plan for the protection of significant archaeological or historical resources. If the licensee and the SHPO cannot agree on the amount of money to be expended on archaeological or historical work related to the project, FERC reserves the right to require the licensee to conduct, at its own expense, any such work found necessary.

3.9.4.3 Rock Island Dam and the Management of Cultural Resources

The Rock Island Dam operates under a license that was issued on January 18, 1989. As part of the approval of this license, a Cultural Resource Management Plan was drafted to avoid or mitigate impacts to cultural resources within the project area. At the time the license was issued, the Cultural Resource Management Plan was concurred upon by the SHPO, the Colville Tribes, and the Advisory Council on Historic Preservation before being finalized. The primary purpose of the Cultural Resource Management Plan was to "assist the Chelan County PUD in achieving compliance with applicable laws, regulations, and guidance pertaining to the management, protection, and enhancement of cultural resources" (Galm and Masten 1988:1).

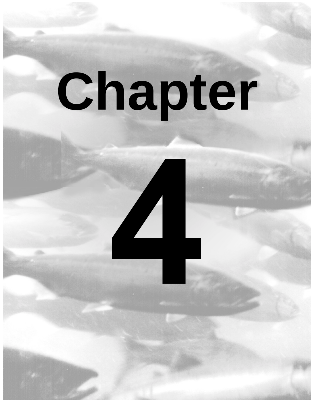
3.9.5 SUMMARY

The project area (which includes the reservoir areas behind Wells, Rocky Reach, and Rock Island dams, and portions of the of the Wenatchee, Entiat, Methow, and Okanogan drainage basins) contains a wide variety of cultural resources. Although many of these resources have been recorded, additional sites and properties no doubt remain to be discovered. Few of the previously-recorded sites have been evaluated for National Register eligibility. Table 3-19 summarizes the types of sites that exist within the project, which were described in the previous subsections of this report, and lists the four National Register listed properties recorded in the project area. While all the site types may be present in all the project areas, their numbers may differ, and not all sites would be eligible for listing in the National Register of Historic Places.

TABLE 3-19. CULTURAL RESOURCE SITE TYPES IN THE PROJECT AREA

PROJECT AREAS	SITE TYPES											
	PREHISTORIC/ETHNOHISTORIC						HISTORIC				TCP[1]	NATIONAL REGISTER-LISTED PROPERTY
	VILLAGE	CAMP	QUARRY	PETROGLYPH	TRAIL	BURIAL	IRRIGATION	TRANSPORTATION	SETTLEMENT	MINING		
Rock Island reservoir	X	X		X	X	X	X	X	X	X	X	Rock Island Railroad Bridge Columbia River Bridge
Rocky Reach reservoir	X	X		X	X	X	X	X	X	X	X	
Wells reservoir	X	X		X	X	X	X	X	X	X	X	
Wenatchee River drainage	X	X	X	X	X	X	X	X	X	X	X	Wenatchee Flat archaeological site
Entiat River drainage	X	X	X	X	X	X	X	X	X	X	X	
Methow River drainage	X	X	X	X	X	X	X	X	X	X	X	
Okanogan River drainage	X	X	X	X	X	X	X	X	X	X	X	

1 TCP = traditional cultural properties
Source: Compiled from Cultural Resources Inventory and Report Records on file at the Office of Archaeology and Historic Preservation.



Chapter 4

Environmental Consequences

Chapter

4 ENVIRONMENTAL CONSEQUENCES

This chapter utilizes the information presented in Chapter 3 to assess the effects of project operations, under each of the three alternatives, on land features/geology/soils, fisheries resources, water resources (quantity and quality), vegetation, wildlife, land ownership and use, recreation, and cultural resources. Note that a summary of the physical, regulatory, and procedural differences among the alternatives is described in detail in Section 2.6. A summary of the environmental consequences of each alternative is presented in Table 2-8, at the end of Chapter 2.

A discussion of the extinction risks for endangered Upper Columbia River spring-run chinook salmon and steelhead is included in Section 4.2, and the pertinent results are summarized for each alternative in the Threatened and Endangered Species sections and in the Columbia River System sections of each alternative (the latter generally addressing the cumulative effects that may result from a given alternative).

This chapter is organized in the same manner as set forth in Chapter 3 and additionally includes unavoidable adverse effects, irreversible and irretrievable commitment of resources, and the relationship between short-term uses and long-term productivity.

4.1 LAND FEATURES, GEOLOGY, AND SOILS

4.1.1 ALTERNATIVE 1 (NO-ACTION)

4.1.1.1 Project Area

Continued operation, maintenance, and planned facility upgrades for the fishways and associated entrances, fishladders, bypass systems (collection entrances and intake screens), turbines, and hatcheries would not result in disturbances to the river bottom. The general geological and soil characteristics of the project area would not be altered by the proposed project modifications. The existing storage and down river movement of sediments at the three projects would continue. Soil erosion along the river shoreline would not be expected to occur as a result of the ongoing activities under Alternative 1.

4.1.1.2 Associated Tributaries

Over the next 50 years, habitat restoration within the Wenatchee, Entiat, Methow, and Okanogan watersheds would occur from ongoing WRIA projects being funded through the Washington State legislature funding, Salmon Recovery Funds Board, Centennial Clean Water Act, Washington State Water Pollution Control, and other Federal, State and local funding sources that are aimed to help restore salmon and steelhead runs in the Mid-Columbia River system. The USFS would also continue to conduct local projects to improve stream conditions for salmonid habitat. The projects include efforts to (1) acquire shoreline areas that are considered important salmonid habitat, (2) remove fish barriers, (3) restore and enhance fish habitat, (4) increase stream flow, and (5) enhance overall water quality.

Fish habitat enhancement projects planned within the watersheds would aid in improving the overall stream geomorphic conditions conducive to fish habitat. These projects would help to decrease sediment transport and delivery, increase large woody debris in streams, reduce bank erosion, increase channel bank stability, increase in-pool channels, and contribute to the overall objective of improving stream channel conditions for fish spawning, rearing, foraging, and resting.

However, short-term increases in turbidity and sedimentation could occur from construction activities such as culvert modifications, placement of in-channel diversions (rock weirs, roots, boles, boulder barbs, and large woody debris) in streams, and construction projects that may require temporary roads for site access. Over the long-term, effects to site geology, soils, and sediments from these projects would be reduced.

4.1.1.3 Columbia River System

Ongoing modifications of project facilities, hatcheries, and spill operations would not alter Columbia River soils and sediment conditions outside the immediate project area. Additional spill derived from release of water stored in the Grand Coulee, Hungry Horse, or Canadian projects would not be beyond current reservoir operating conditions.

Modifications of other lower Columbia River hydroelectric projects are under consideration by State and Federal agencies including the removal of some Snake River dams and operation changes at other projects (BPA et al. 1995a). Changes at the lower Columbia River dams would not alter geomorphic conditions at upstream hydroelectric facilities, although lower Columbia River dam removal could benefit upper Columbia River anadromous fish stocks.

4.1.2 ALTERNATIVE 2

4.1.2.1 Project Area

Section 7 consultation and associated facility improvements for fish passage would not result in significant changes in soils and geologic resources in the project vicinity, unless tributary habitat improvement projects were initiated to aid in the recovery of listed species. If this were the case, the effects on land features, geology, and soils would likely be consistent with similar projects discussed under Alternative 3. If drawdowns were to occur (possible under either Alternatives 2 or 3) the effects would be more significant.

Drawdown Effects

Although reservoir drawdown below the current operating range is not planned or currently recommended for the Wells, Rocky Reach, and Rock Island projects, drawdown could be proposed under Alternatives 2 or 3 as an approach to facilitate the downstream passage of juvenile salmonids if fish passage or survival goals are changed or project monitoring indicates the goals are not being achieved.

If drawdown is considered a viable option for any dam over the next 50 years, a separate EIS would be prepared with an in-depth analysis conducted for each resource affected.

Increased reservoir drawdown has been considered to improve fish passage conditions at other Columbia basin projects (BPA et al.1995a; U.S. Army Corps of Engineers 1992; U.S. Army Corps of Engineers 2000). The types of reservoir and downstream impacts to be expected from large reservoir drawdowns was tested and modeled on the lower Snake and Elwha rivers (BPA et al.1995a; U.S. Army Corps of Engineers 1992; National Park Service 1995; BOR 1995; FERC 1993a; Stoker and Williams 1991) and also occurs at hydroelectric projects where large reservoir fluctuations are a part of normal operations (Washington Water Power

Company 1998; Seattle City Light 1994; Riedel et al. 1992).

Reservoir drawdown would resemble natural river conditions, reducing the area and depth of the project reservoirs. Water flow velocities would increase and channel cross sectional area would decrease to the original size. The deltas at the mouths of the tributary streams have likely increased in size over time due to the influence of the slack water reservoirs. Sediment entrained in the higher velocity flows in the tributaries settles out rapidly as velocities decrease at the reservoir. These enlarged deltas could present barriers to fish migrations until a new channel is cut through the delta. This downcutting would increase turbidity levels in the mainstem over the short-term.

When new annual drawdown levels are established, a major increase in erosion occurs at the new shoreline levels by wave and other shoreline erosion processes. Increased erosion occurs in the exposed drawdown zone from wind, rain, run-off, and freeze/thaw processes. Additional slumping of steep shoreline areas is common. These erosion processes decline with time as sediment availability decreases and sediment is redistributed in the reservoir.

4.1.2.2 Associated Tributaries

No changes would occur to geologic conditions and soils within the four tributaries as a result of Section 7 implementation under Alternative 2 for the Wells, Rocky Reach, and Rock Island projects (provided habitat improvements are not required to aid in the recovery of listed species). Independent actions by local, State, and Federal agencies are expected to continue to occur as described under Alternative 1. The potential benefits and impacts associated with these activities are also described under Alternative 1.

4.1.2.3 Columbia River System

Expected effects from other Columbia River project changes are described under Alternative 1. In addition, if drawdown is tested or adopted under Alternatives 2 or 3, on one or more of the three projects, downstream suspended sediment and turbidity would increase. The Snake River drawdown tests and model analysis indicate that, during the first few years of reservoir drawdown, increased downstream suspended sediment would affect the next downstream reservoir.

4.1.3 ALTERNATIVE 3

4.1.3.1 Project Area

Similar to the other alternatives, the project improvements planned for fishways, bypass systems, and turbine units under Alternative 3 would not alter project area geology, soils, turbidity, and sedimentation from existing conditions. Effects from drawdown, as described under Alternative 2, would also occur under Alternative 3 if drawdown were implemented.

4.1.3.2 Associated Tributaries

Alternative 3 would provide PUD funding for fish habitat improvement projects in the four tributaries. Specific projects identified in the HCPs (NMFS et al. 1998b) that would help to improve geomorphic conditions in the tributaries include:

- protection of the lower White River for minimizing future effects to the unstable alluvial materials;
- protection of wetlands at Lake Wenatchee and the mainstem of the Methow River to help avoid future increases in sedimentation and turbidity;
- recruitment of large woody debris in the Wenatchee River to restore channel stability;

- restoration of floodplain function in all tributaries to reduce sedimentation and turbidity;
- protection of riparian bottomlands in the Entiat River watershed to reduce the potential of sedimentation, shoreline erosion, landslides, and turbidity;
- restoration of side channel functions in the Methow River to aid in minimizing shoreline slumping and erosion; and
- revegetating and stabilizing the erosive banks on the Okanogan River between the Similkameen River and Omak to avoid future erosion.

Proposed construction projects that could increase turbidity and sedimentation over the short-term include modification of the diversion dams at Leavenworth National Fish Hatchery and Icicle Irrigation District, culvert modifications planned at several streams, placement of in-channel habitat structures, and construction projects that may require temporary roads for site access. Over the long-term, effects to site geology, soils, and sediments from these projects would be reduced.

4.1.3.3 Columbia River System

There are no specific activities planned under Alternative 3 that would alter current land, soil, or sediment conditions along the Columbia River (provided drawdown were not implemented). Tributary restoration projects would not effect Columbia River sediment conditions. Any increases in river turbidity from instream restoration work would be minimized and diluted prior to reaching the Columbia River. Tributary restoration projects would likely result in decreased watershed and riverbank erosion and reduced sediment delivery to the Columbia River. These changes would not alter downstream Columbia River sediment, shoreline, or soil conditions. Stable reservoir levels under Alternative 3 would also maintain current shoreline and sedimentation conditions in the reservoirs.

4.1.4 RECOMMENDED MITIGATION

Some habitat improvement projects in the four tributaries would likely result in short-term erosion and turbidity effects. Construction related projects along river and stream shorelines would likely require a State Joint Aquatic Resource Permit Application (JARPA) and other related permits that evaluate project effects on the existing natural resources, including geology and soils. Through project permitting, BMPs would be identified, and soil erosion and control plans would be required. Review of these construction projects for potential erosion, sedimentation, turbidity, and landslide effects are important considerations to ensure that fish habitat improvements protect existing natural resource conditions, to the extent practicable.

4.2 FISHERIES RESOURCES

Four fish species, currently listed as threatened or endangered in the Mid-Columbia River basin, are expected to occur within the project area or in areas potentially affected by project operations. These species are:

- Columbia River Distinct Population Segment of bull trout (listed as threatened on June 10, 1998; 63 FR 31674),
- Upper Columbia River spring-run chinook salmon (listed as endangered on August 2, 1999; 64 FR 41835),
- Upper Columbia River steelhead (listed as endangered on August 18, 1997; 62 FR 43974), and
- Middle Columbia River steelhead (listed as threatened on March 25, 1999, 64 FR 14517).

Although adult and juvenile bull trout are occasionally observed passing the projects, little is known about their migratory behavior in the Mid-Columbia River. Specific measures to address the effects of project operations on bull trout are not included in the existing mitigation and compensation programs established through the FERC license and settlement agreements. At this time, informal consultation between FERC and the USFWS has been initiated in an attempt to develop information specific to this species. This information can then be used to determine appropriate mitigation actions at the projects.

Effects from the Wells, Rocky Reach, and Rock Island dams on Middle Columbia River steelhead are most likely limited to changes in water quality. Measures implemented at the projects to address water quality will be the same for each of the listed species. For this reason, the following discussions of threatened and endangered species relate specifically to Upper Columbia River spring-run chinook salmon and steelhead.

There are three alternatives being considered in this EIS to protect endangered Upper Columbia River spring-run chinook salmon and steelhead: No action (Alternative 1), Endangered Species Act Section 7 consultations (Alternative 2), and HCP Section 10 permits (Alternative 3). Although there are fundamental differences between the two action alternatives (Alternatives 2 and 3), both will provide protection to the listed species. Alternative 3 will additionally provide the same level of protection to all of the Plan species (Upper Columbia River spring-, summer-, and fall-run chinook, sockeye and coho salmon, and steelhead). The no-action alternative represents a continuation of the existing conditions, without implementing measures that may aid in the recovery of listed species. As a result, Upper Columbia River spring-run chinook salmon and steelhead have a high likelihood of extinction under Alternative 1 within the next 100 years. For this reason, Alternative 1 is considered to be non-viable.

Independent tributary habitat improvements, in addition to those that may be required under Alternative 2 or proposed under Alternative 3, and improvements in fish passage survival at the lower Columbia River dams are expected to benefit Upper Columbia River anadromous fish species. Modifications to harvest regulations and hatchery practices likely to occur over the next 50 years will also benefit these stocks. All of these beneficial actions will occur for all three alternatives presented in this EIS.

Other activities that are likely to affect both the listed and non-listed species are also expected to occur in the region. These activities may or may not be directly linked to the Mid-Columbia River hydroelectric projects. For example, the hatchery programs that were developed to mitigate for inundation by the PUD projects are covered under a separate Endangered Species Act consultation process, and will continue regardless of the consultations on project operational impacts. Other stipulations outlined in the settlement agreements between the PUDs and the fishery agencies and Tribes will also continue unless specifically modified by either Alternatives 2 or 3.

Because there are a limited number of measures that can be implemented at the Mid-Columbia River projects to increase fish passage survival, many of the protection measures are expected to be similar for each of the action alternatives. In addition, many of the operational protocols that the projects currently operate under were established through the collaborative work of PUD, State, Federal, and Tribal biologists, so they are unlikely to change substantially under any of the alternatives. Therefore, these operational measures and protocols discussed under Alternative 1 will also generally apply to the two action alternatives, unless specific differences are identified.

The intent of Alternative 2 is to develop long-term protection and recovery plans for listed species. Any means necessary to accomplish this goal will be required at the projects, up to full mitigation of the project effects. The intent of Alternative 3 is to additionally protect all of the Plan species, establishing criteria for implementing correction and mitigation measures to achieve no net impact. These no net impact measures include funding hatchery supplementation and tributary habitat improvements to mitigate for the unavoidable project passage related mortality.

As discussed previously, the potential measures proposed under Alternative 2 are not currently supported by either FERC or the PUDs. Extensive negotiations would likely be required under Alternative 2 to resolve biological and technical issues before they could be implemented. This would likely delay any assistance to listed species for some time. Measures under Alternative 3 however, would be implemented sooner because of PUD support for the HCP procedures, protocols, and standards (some of them have already been implemented).

One potential measure that could be recommended under either Alternatives 1 or 2 during the next 50 years (which would have significant and substantial environmental effects to many of the existing natural, physical, and social resources) would be reservoir drawdown to natural river levels. Natural river drawdowns would help to mimic the natural river conditions that existed prior to the construction of the hydroelectric facilities, and thereby improve survival. Although not recommended by a Federal, State, or local agency at this time, the review of natural river drawdown was requested by organizations during public scoping for this EIS. Consequently, natural river drawdown at the three dams (Wells, Rocky Reach, and Rock Island) has been evaluated at a brief summarizing level to help understand and compare the overall differences between the alternatives.

Although natural river drawdown is not an option under Alternative 1, it could be evaluated during relicensing procedures. The current FERC licenses expire in 2006, 2012, and 2029 for the Rocky Reach, Wells, and Rock Island projects, respectively. Drawdown to minimum operating pool, which is an option under the current licenses, has not been shown to increase juvenile survival in the Mid-Columbia River. Therefore, it was not evaluated in this EIS.

4.2.1 QUANTITATIVE ANALYTICAL REPORT

The cumulative effects associated with the operation of the Mid-Columbia River projects, and the projected changes as a result of implementing the survival and tributary improvements of the HCPs were assessed in the Mid-Columbia River Quantitative Analytical Report (QAR) (NMFS 2000c draft). The report summarizes available information for Endangered Species Act listed Upper Columbia River steelhead and spring-run chinook salmon, reviews alternative approaches to estimating the risks of extinction and recovery perspectives, and provides preliminary estimates of the relative risks of extinction under a range of alternative management and climate and environmental scenarios. The QAR also provides analyses of the potential survival improvements that could be gained throughout the life-cycle of listed Upper Columbia River salmonids from hydropower system modifications, enhanced habitat, and changing climate and environmental conditions (i.e., ocean survival).

Three independent populations (i.e., an aggregation of one or more local breeding units (demes) that are closely linked by exchange of individuals among themselves, but are isolated from other independent populations) of wild spring-run chinook salmon and steelhead were identified in the QAR – one each on the Wenatchee, Entiat, and Methow rivers. The QAR analyses are intended to determine the following information for these populations:

- **Extinction Risks** – Assess the risks of extinction for the major wild populations of the Upper Columbia River steelhead and spring-run chinook salmon evolutionarily significant units given a continuation of recent management and environmental conditions associated with adult returns.

- **Extinction Risk Reductions** – Assess how the projected extinction risks would be affected by proportional increases in the average return per spawner ratios (i.e., the number of return spawners divided by the total number of parent spawners for each brood year).

- **HCP Effects** – Specifically assess how the extinction risks and recovery probabilities might be affected by the implementation of survival and tributary improvements called for in the three HCPs.

- **Combined Effects** – Determine the projected combined effect of the survival and tributary improvements called for in the HCPs and potential additional actions involving hydropower, habitat (tributary and estuarine), and hatcheries throughout the basin.

- **Other Effects** – Determine if additional survival improvements would be needed to achieve survival and recovery objectives for these runs.

4.2.1.1 Extinction Risks

The extinction risks for wild Upper Columbia River steelhead and spring-run chinook salmon were assessed by estimating the total annual run sizes and determining the resultant return per spawner ratios. To determine annual run sizes, estimates of prespawning mortality, captured broodstock, and harvest rates were added to the annual escapement numbers recorded during spawning ground surveys. The total component of hatchery fish could then be determined and factored out of the spawning populations to estimate total adult returns from wild, naturally spawning parents. The annual returns were then separated into age classes to determine the contribution from each broodyear. The annual returns from each broodyear were summed to estimate the total number of adults that returned from wild, naturally spawning parents each year (i.e., the return per spawner ratio).

A stable population requires in excess of one returning adult for every adult spawner in order to account for harvest rates and in-stream adult mortality. At spawning, a stable population requires a minimum of one return spawner for each spawning parent (i.e., a return per spawner ratio of 1.0). If this ratio is less than one, the population decreases and conversely, the risk of extinction increases. The average return per spawner ratios between 1980 and 1997 for the Wenatchee, Entiat and Methow river spring-run chinook salmon populations, for example, were on the order of 0.5 to 1.

Return per spawner ratios are a common way of expressing the productivity of salmon stocks. They reflect the average rate of replacement over the life of a generation – typically 4 to 5 years for chinook salmon. Return rates can also be expressed as annual growth rates (often termed *lambda*). The recent year return rates for Upper Columbia River spring-run chinook salmon translate into annual return rates of 0.90 to 0.95. In other words, populations have been trending down at a loss rate of 5 to 10 percent per year.

Estimating the return per spawner ratio for wild steelhead was complicated by the relatively high proportion of hatchery steelhead that spawn naturally. It is possible that natural production of wild steelhead in the Upper Columbia River is being heavily subsidized by constant inputs of hatchery spawners. Between 1976 and 1992 the average percent of the spawning populations comprised of wild origin adults was estimated at 27.9 and 11.2 percent in the Wenatchee/Entiat and the Methow rivers, respectively. This indicates that the constant input of hatchery fish each year may be masking very low return per spawner ratios for wild fish, whose numbers have dropped to a fraction of historic levels.

Given the ultimate focus of Endangered Species Act objectives on naturally self sustaining populations of wild fish, the steelhead productivity analyses in the QAR centered on a special case – scenarios in which hatchery inputs into natural spawning areas would immediately cease. The extinction risks and recovery analyses reported in the QAR all reflect this hypothetical assumption.

To estimate return per spawner ratios for wild steelhead, an assumption must be made concerning the spawning effectiveness of hatchery fish. Assuming a 100 percent spawner effectiveness level for straying hatchery fish, the average return per spawner ratios for wild steelhead between 1976 and 1996 on the Wenatchee/Entiat and Methow rivers were 0.41 and 0.28, respectively. However, with the assumption that hatchery fish were only 50 percent effective at spawning naturally, the return per spawner ratios for wild steelhead increased to 0.66 and 0.45, respectively. Assuming that hatchery spawners were only 25 percent effective at spawning further increased the return per spawner ratios for wild steelhead to 0.70 and 0.65, respectively. The QAR modeled the recent return per spawner ratios to generate projections of temporal trends or patterns in spawning escapement that can be compared to specific extinction risk criteria over time.

Three population level criteria were considered in the QAR:

- **Absolute Extinction Level** - Defined as one or fewer wild spawners in five or more consecutive years.

- **Quasi-Extinction Level** - Defined as 50 or fewer spawners (Methow and Wenatchee rivers) or 30 or fewer wild spawners (Entiat River) for 5 or more consecutive years. This is the abundance level at which a population is believed to be at extremely high risk of extinction in the immediate future and faces risks that are not usually incorporated into simple population extinction models.

- **Cautionary Level** – Defined as 1,200 or fewer wild spawners per year for the Wenatchee River, 750 for the Methow River, and 150 for the Entiat River.

Interim population recovery goals for spring-run chinook salmon populations were set in the QAR at: 3,750 spawners/year in the Wenatchee River, 2,000 spawners/year in the Methow River, and 500 spawners/year for the Entiat River. Interim recovery goals for the three steelhead populations were set at: 2,500 spawners for the Wenatchee and Methow rivers, and 500 spawners for the Entiat River.

4.2.1.2 Factors Affecting the Extinction Risks

Major resource management factors affecting the extinction risks of the Upper Columbia River spring-run chinook salmon and steelhead include:

- harvest,
- hatchery production,
- habitat quantity and quality, and
- hydropower.

These factors are directly influenced by resource management practices and can be altered to increase the survival of listed species. An additional factor, which is independent of management practices, is the fluctuations in climate and environmental conditions. These fluctuations are believed to have a significant affect on the ocean survival of anadromous fish species, although the process is not well understood. A key objective of the QAR analyses is to depict the relative improvement in survival necessary to achieve extinction risk and recovery objectives under different assumptions about future climate and environmental survival scenarios.

Harvest

Harvest impacts on Upper Columbia River spring-run chinook salmon and steelhead are dominated by in-river fisheries. Until the early 1970s, Upper Columbia River spring-run chinook salmon were harvested along with returning Snake River stocks in lower Columbia River commercial and sports fisheries (WDFW 1999). Harvest rates in those fisheries ranged between 30 and 50 percent per year. However, these fisheries were curtailed significantly in the early 1970s in response to declines in returns and recognition of treaty harvest needs. In recent years, harvest rates have been reduced further due to listings under the Endangered Species Act.

Steelhead harvest rates in lower river commercial fisheries were relatively high through the 1960s. Direct commercial harvest of steelhead in non-Indian fisheries was eliminated by legislation in the early 1970s. Incidental impacts to steelhead through fisheries directed at other species continued in the lower river, but at substantially reduced levels. In the late 1970s and early 1980s, recreational fishery impacts to steelhead in the Upper Columbia River escalated to very high levels in response to increasing returns augmented by substantial increases in hatchery production and harvest reductions in the lower Columbia River. Harvest rates on wild steelhead between 1975 and 1985 averaged 10 percent in the lower Columbia River and 50 to 75 percent above the Wells Dam. In 1985 steelhead recreational fisheries in this region (and in other Washington tributaries) were changed to mandate the release of wild fish. Treaty harvest of summer-run steelhead (including returns to the Upper Columbia River) occurs mainly in mainstem fisheries directed at up-river bright fall-run chinook salmon.

Hatchery Production

Each of the Upper Columbia River tributaries has an associated set of hatchery production programs. Hatchery production, especially of steelhead, increased dramatically in the 1960s and 1970s. Steelhead runs have been predominantly of hatchery origin since at least the early 1970s. Adults returning from these programs can stray and contribute to the production of natural spawning areas. However, the effectiveness of hatchery fish spawning naturally is unknown. The uncertainty related to the historical effectiveness of hatchery fish spawning in the wild has a significant effect on estimates of the wild population productivity. A more detailed discussion of the effects of hatchery programs on wild fish populations is presented in Section 3.2.4.

Habitat Quantity and Quality

Upper Columbia River fish runs have been substantially impacted by habitat degradation due to mining, logging and grazing activities within the tributaries, particularly in the late 1800s and early 1900s. Although habitat conditions are believed to have substantially improved over the last 100 years, the status of tributary habitat is still a limiting factor to the fish population production capabilities of the Upper Columbia River region. A detailed discussion of tributary and reservoir habitat conditions is presented in Section 3.2.9.

Hydropower

The focus of the proposed HCPs is to minimize the effects of the Mid-Columbia River hydroelectric projects on the anadromous fish species in the region. However, these species are also affected by the four federal hydroelectric projects on the lower Columbia River (Bonneville, The Dalles, John Day, and McNary dams) (see Figure 1-1). The impacts of these lower river projects are expected to be similar to those discussed in Section 3.2 for the Mid-Columbia River projects.

Climate and Environmental Conditions

In recent years, theories regarding the potential effect of climate and environmental cycling have gained considerable attention. The available data series for Upper Columbia River spring-run chinook salmon dates from the late 1950s. A set of alternative future climate and environmental scenarios was developed based on this information. The data series for steelhead was much shorter, only dating from the late 1970s. To date, the steelhead analyses conducted for the QAR have included only one background climate and environmental scenario based on this information. Steelhead analyses have focused primarily on the critical question of the relative effectiveness of hatchery spawners.

Three different scenarios reflecting the range of possible future climate conditions were the focus of QAR modeling assessments for spring-run chinook salmon. The first major scenario assumes that background survival conditions estimated for years since 1970 reflect the year to year variation that will be experienced by Upper Columbia River spring-run chinook salmon in the future. This scenario assumes that the more recent low return rates will be balanced to some extent by higher returns, such as those experienced in the early 1970s.

A second major scenario reflects the assumption that there has been a major downward shift in climate and environmental conditions in recent years, possibly as an effect of long-term natural cycling. This scenario assumes that recent climate regimes (1982 – 1996) and associated spawner/recruit ratios would persist well into the future.

A third scenario, reflecting the survival rates observed over the last 30 years (mid-1960s to mid-1990s), was also evaluated). This scenario addresses the hypothesis that long-term cycling in North Pacific ocean and atmospheric conditions has an important effect on salmon survival. In particular, associations between an index of North Pacific oceanographic and atmospheric conditions, the Pacific Decadal Oscillation index, and salmon production have been postulated. This index is characterized by a 30-year cycle, with a major change from positive to negative conditions in the mid-1970s. Inspection of the data series indicates a high level of year-to-year variability within the proposed cycle.

4.2.1.3 Action Analysis

A number of specific actions (including the Wells, Rocky Reach, and Rock Island HCPs) to improve the survival of spring-run chinook salmon and steelhead have been implemented or are under consideration. While the focus is on survival improvements at hydroelectric dams, the contribution of the proposed HCP-funded habitat improvements was also considered in the QAR analyses (these analyses also assumed that the survival goals set forth in the HCPs also applied to the Wanapum and Priest Rapids dams). The initial QAR effort was aimed at determining the survival improvements necessary for protecting and recovering wild, Upper Columbia River spring-run chinook salmon and steelhead and did not assess the effects of the long-term supplementation program envisioned in the proposed HCPs.

Recovery of wild, Upper Columbia River spring-run chinook salmon and steelhead populations will likely require improved survival throughout the life cycle. The focus on hydropower actions reflects the genesis of the QAR effort, to provide analytical tools to use in the assessment of proposed actions at the Mid-Columbia River projects. That fact does not mean that the full burden of achieving survival rates sufficient to sustain natural production would necessarily fall on the PUD projects. The Upper Columbia River stocks are also subject to hydroelectric dam passage mortality in the lower Columbia River, due to the four mainstem federal hydropower projects. Therefore, potential survival changes were assessed given a range of possible scenarios for configuration and operation of the lower river projects.

4.2.1.4 Harvest

The basic analyses conducted in the QAR assume that recent average harvest rates (encompassing incidental sport and commercial catches) would continue into the future. Those harvest rates generally reflect recent reductions imposed in response to stock listings and general downturns in abundance.

4.2.1.5 Interim Recovery Goals And Extinction Risks

Results of the modeling exercise support the contention that hatchery spawner effectiveness is a key uncertainty relative to the level of survival improvements necessary to meet extinction risk and recovery criteria for steelhead. There are two basic rationale supporting the sensitivity analysis of hatchery effectiveness; observations of spatial and temporal differences between hatchery and wild steelhead spawning in the Upper Columbia River tributary streams, and study reviews of the relative effectiveness of hatchery spawners throughout the Columbia River basin.

Natural stock productivity was evaluated under four alternative assumptions regarding hatchery effectiveness:

- hatchery spawners being equally effective as wild spawners;
- hatchery spawners 75 percent as effective as wild spawners;
- hatchery spawners 50 percent as effective as wild spawners; and
- hatchery spawners 25 percent as effective as wild spawners.

Achieving the proposed HCP passage survival standards will require significant survival increases over recent historical (1980-94) survival levels. Even when they are achieved, hatchery production will be utilized to partially compensate for the remaining unavoidable project mortality. The remaining impacts are to be mitigated through habitat improvements specifically targeted on increasing the survival of anadromous fish populations above the PUD dams – including listed spring-run chinook salmon and steelhead.

The proposed HCP actions must also meet Endangered Species Act survival and recovery criteria. For the long-term, listed stocks must be self-sustaining without support from artificial efforts such as supplementation. Supplementation with artificial production is specifically recognized however, as an important short-term tool to maintain stocks while survival is increased to levels that will allow for self-sustaining production.

In the case of Upper Columbia River spring-run chinook salmon, supplementation programs are justifiable based on the extremely low numbers of returning adults produced from wild, natural spawning fish in recent years, combined with the recognition that it may be several years before hydropower and habitat based survival improvements are realized. The modeling analyses conducted to date through the QAR have not directly incorporated mechanisms reflecting the long-term risks of continued supplementation. However, such risks are considered relatively low when compared to the short-term risks associated with the existing low population sizes. Assessing the potential effects of supplementation from a longer-term perspective is an important element of the monitoring and evaluation component of the proposed HCPs.

Steelhead returns into the Upper Columbia River are heavily dominated by returning hatchery fish. Until recently, returning hatchery adults spawning in the wild were predominately of Wells Hatchery stock, which is considered by NMFS to be negatively influencing the long-term health and survival of wild steelhead. As a result of consultation efforts however, the Upper Columbia River steelhead hatchery programs are in transition to locally adapted broodstocks.

Due to long-term uncertainty associated with effectiveness of hatchery supplementation, the QAR analyses did not directly incorporate continued supplementation as envisioned under the proposed HCPs. However, other HCP actions such as dam passage survival and off-site mitigation were considered in the QAR analysis. In addition, the QAR also assumed that the survival improvements called for at the hydroprojects, and through off-site mitigation, occur instantaneously. In fact, it may take several years or, in some cases, a decade or more before the survival benefits of certain actions (e.g., habitat improvement) are fully realized. Continued supplementation with an appropriate brood stock represents an important factor to consider when assessing alternative recovery actions. However due to the Endangered Species Act requirements, long-term supplementation was not included in the QAR model predictions.

4.2.1.6 Habitat Quantity and Quality

The proposed HCPs prioritize habitat protection for those stocks that are currently performing relatively well, and habitat restoration for those stocks that are performing poorly but that have significant potential for improvement. Within these two categories, the proposed HCPs state that "the highest priority for maintaining biological productivity will be to allow unrestricted stream channel diversity and floodplain function."

The proposed HCPs provide a mechanism for directing PUD funding towards anadromous fish habitat protection and restoration priorities in the Upper Columbia River basin. A goal of the proposed program is to generate survival improvements equivalent to 2 percent per project, for each tributary stock.

Additional habitat improvements in the Upper Columbia River basin either have, or are being identified through various local, State-level or national processes. Habitat improvements from these processes, however, were not considered in the QAR analysis. The draft Federal Columbia River Power System Biological Opinion and the draft All H paper (Federal Caucus 2000) also call for extensive off-site mitigation to improve the survival of listed salmon populations, including the Upper Columbia River populations. Quantifying the potential survival improvements of the various states, federal, and tribal habitat actions, outside of those directly incorporated into the HCP process, was not a task set forth in the QAR analysis.

4.2.1.7 Hydropower

<u>Mid-Columbia River Projects</u>

The QAR analyses assume that all five of the Mid-Columbia River hydroelectric dams would be operated to meet the proposed HCPs project specific survival standards. (Even though Grant County PUD is no longer a participating entity in the HCP process, Endangered Species Act Section 7 consultations for Wanapum and Priest Rapids dams are expected to be similar to the Section 10 consultations for the HCPs.)

The HCPs set long-term standards for passage survival through the Mid-Columbia River PUD projects. The standard at each project is based on achieving no less then 91 percent total project survival for juveniles and adults combined. A rough estimate of reach survival from each of the Upper Columbia River tributaries through the Mid-Columbia reach (from each of the tributaries to below the Priest Rapids Dam) was generated for juvenile spring-run chinook salmon and steelhead.

(For comparison purposes: Although information regarding juvenile passage survivals in the Upper Columbia River prior to dam construction is unavailable, historical estimates of spring-run chinook salmon and steelhead survival are available for the 318 mile reach from the Whitebird trap to Ice Harbor Dam in the Snake River, prior to the construction of the intervening lower mainstem Snake River dams [Smith et al. 1998]. Applying that survival rate to the specific reaches from each of the Upper Columbia River tributaries to a point below the Priest Rapids dam results in average pre-dam juvenile reach survival estimates of between 98 and 99 percent.)

<u>Lower Columbia River Projects</u>

The historic passage survival estimates compiled through the Plan for Analyzing and Testing Hypothesis (PATH) process were used to estimate average base period survival through the section of river from the McNary Dam through the Bonneville Dam. The average per project survival (87 percent) from Lower Granite through John Day projects was assumed for survival through the two lower river dams (The Dalles and Bonneville). McNary and John Day project survival was assumed to be equal to the average of the Upper Columbia River projects (85 percent). The resulting aggregate estimate of in-river survival from McNary to Bonneville was 51.5 percent.

A number of options for configuring or operating the federal hydroelectric projects on the lower mainstem of the Columbia River are under consideration. For the purposes of the QAR analysis, four alternatives were analyzed in combination with the Upper Columbia River mainstem survival standards described previously:

1. *93 percent Survival Objective*: Improve passage at the lower river projects to meet the same standards set forth in the proposed HCPs for the Mid-Columbia River PUD projects.

2. *93 percent Survival plus John Day drawdown*: Implement John Day drawdown and meet the 91 percent HCPs survival standard at each of the remaining projects.

3. *91 percent McNary Transport plus 91 percent Project Survival*: Re-establish barge transport from McNary Dam plus meet the 91 percent HCPs survival standard at the lower Columbia River projects.

4. *Aggressive Federal Columbia River Power System In-river Improvements*: Maximum survival improvements at each of the lower Columbia River projects as developed through the federal caucus initiative plus offsite mitigation to full compensation or achievement of standards.

4.2.1.8 Modeling Results

Mid-Columbia Projects

Based on juvenile survival rates of 86-88 percent per project for the base period of 1982-1996, achieving the proposed HCPs passage survival standards would increase Mid-Columbia River reach survival by 16-25 percent for steelhead, and by 21-35 percent for spring-run chinook salmon (the range accounts for the differences in the number of Mid-Columbia River PUD dams that each population migrates past). Additional survival improvements through tributary habitat funding under the proposed HCPs would increase survival an additional 6-10 percent for both steelhead and spring-run chinook salmon. (Given the Endangered Species Act focus on self sustaining wild populations in the absence of hatchery support, the assumed 7 percent per project survival increases from supplementation were not added into the model at this point.)

Lower Columbia River Projects

Additional passage survival improvements on the order of 20 to 50 percent would be required for spring-run chinook salmon in order to meet the proposed HCPs long-term survival standards at the lower Columbia River dams. Steelhead results were similar, but were additionally complicated by basic uncertainties regarding hatchery fish spawning effectiveness. By adding the lower Columbia River hydroelectric project survival improvements, the probability of meeting the risk/recovery criteria significantly improved.

Achieving the high end of the range for survival improvements at the lower Columbia River projects would require resolving key uncertainties regarding the relative survival of Mid-Columbia River origin smolts collected and transported from McNary. Although data from early transport control studies does not indicate high loss rates, data from PIT tag studies on Snake River fish in the early 1990’s does support a high mortality rate for McNary Dam collections.

4.2.1.9 Climate and Environmental Conditions

The modeling results indicated that the largest increases in survival necessary to meet risk/recovery criteria were required when recent climate conditions were assumed to persist for the next 100 years (brood years 1980 – 1993: migration years 1982 – 1996). Under the alternative assumption that future background survival conditions would reflect the range seen since 1970, the proposed HCPs survival improvements for spring-run chinook salmon runs approached or exceeded (in the case of Wenatchee population) the level projected to reduce the extinction risk at 100 years to below 5 percent. However, substantial additional improvements in survival would be needed to meet long-term recovery objectives. The fewest additional survival improvements were required when return per spawner ratios for future years were based upon historical (1960's – 1990's) estimates.

All three spring-run chinook populations modeled had high long-term (100 year) extinction risks under the assumption of continued low return per spawner ratios. Model runs based on data from the Wenatchee and Entiat river populations had the highest risk. The model analyses indicated a substantial risk of extinction over the next 25-50 years, in the absence of hatchery supplementation, mainstem survival improvements, or positive climate and environmental changes. (Additional survival improvements from hatchery supplementation were not considered in this set of model runs.)

4.2.1.10 Hatchery Production

A set of model runs were made under the assumption that short-term supplementation could successfully boost return levels up to the proposed interim recovery goals. Once the interim recovery standards were achieved, supplementation was ended. Analysis of the proposed actions with respect to Endangered Species Act objectives requires an assessment of the ability of a population to sustain itself in the absence of long-term supplementation or other artificial support. As a result, it was necessary to run the QAR models with the assumption that short-term supplementation would be suspended after interim recovery population levels were achieved. (Although these model runs assumed that short-term hatchery supplementation would cease after the interim recovery goals were met, supplementation under the HCP would not be suspended unless monitoring information indicated a significant detrimental impact to Endangered Species Act listed species.)

For this analysis, the short-term extinction risks were represented by projections at 10 and 25 years, while long-term risks were represented at 75 and 100 years. The extinction risks over the long-term were almost equal to the projected risks in the absence of short-term supplementation, although, for a period of time, short-term supplementation was able to sustain production even under the recently adverse climate and survival conditions. Improvements in passage, habitat, and climate conditions would be necessary to allow for sustainable natural production in the absence of long- or short-term hatchery supplementation.

Lower and Mid-Columbia River Projects Combined

The combined effects of the potential survival improvements from the lower Columbia River federal hydropower projects and those that could be gained by meeting the proposed HCPs survival standards can be calculated by multiplying the estimated survival levels in each section of the river. The results indicate that the greatest survival improvements are needed in the Wenatchee River (for spring-run chinook salmon) and in the Methow River (for steelhead).

Wenatchee Spring-Run Chinook Salmon

Under the assumption that future natural survival conditions would remain at the levels experienced by the 1980-94 broods, the projected survival improvements for the proposed HCPs actions would not increase overall productivity of the Wenatchee River spring-run chinook salmon run sufficiently to meet interim recovery targets. As discussed earlier however, even dam removal would fail to meet these recovery targets under these same survival conditions. However, by incorporating the Lower Columbia River improvements called for in the draft Federal Columbia River Power System Biological Opinion (including the benefits of off-site mitigation) these survival projections increased, although not enough to meet extinction and recovery criteria. Under the combined scenario, an additional 7 percent survival improvement would be required to meet the 100-year extinction criteria (less than 1 percent chance of 0 spawners at 100 years). Substantial additional survival improvement (on the order of 100 percent) would be required to meet the interim recovery criteria under this scenario.

If future environmental conditions result in survivals similar to those experienced since 1970, the combined effects of the draft Federal Columbia River Power System and the proposed HCP actions would exceed the 100-year extinction criteria for the Wenatchee River spring-run chinook salmon population. In addition, the additional survival improvements necessary to meet the interim recovery criteria would be greatly reduced (an additional 22-27 percent survival improvement as opposed to the approximately 100 percent improvement required using the 1980 – 1994 survival rates).

Survival gains from the proposed HCP actions alone would be projected to exceed the improvements needed to meet the 100-year extinction criteria if future environmental conditions are similar to those seen since 1960 - including the chance of some relatively good survivals (e.g., the early 1960s) and some poor survivals (e.g., the 1990s).

Under the assumption that future climate conditions would reflect the long-term averages (1960 – 1996), Wenatchee River spring-run chinook salmon would be projected to meet both the extinction risk criteria and the interim recovery abundance level under the combination of actions in the proposed HCPs and the survival improvements on the lower Columbia River.

Methow River Steelhead

The steelhead assessment indicates that the proposed HCP survival improvements alone would not meet survival improvement requirements for satisfying either the extinction risk or the interim recovery level criteria under a range of possible hatchery spawner effectiveness assumptions (25 to 100 percent). However, a combination of projected survival improvements from the proposed HCP actions and those from the lower Columbia River survival improvements would meet both the extinction risk and interim recovery criteria if hatchery spawner effectiveness is 25 percent or less. If hatchery spawner effectiveness has been on the order of 50 percent, the projected survival improvements of the combined HCPs and Federal Columbia River Power System aggressive action package come close to meeting the 100 year extinction risk criteria. However significant additional improvement would be needed to achieve the interim recovery objectives. The extinction risk criteria could be met at 75 percent spawning effectiveness, but the interim recovery criteria would not be satisfied at that level when poor ocean conditions prevailed. If hatchery fish are 100 percent as effective in contributing to natural production as wild fish, then the combined survival improvements fall short of meeting the recovery criteria.

The steelhead model runs do not include long-term (7 percent) hatchery supplementation for summer-run steelhead. Life cycle model runs incorporating long-term supplementation indicate that supplementation alone could withstand the downturn in survivals even under recent climatic regimes. However, when utilizing long-term supplementation, a high fraction of returning spawners would be of hatchery origin. The long-term effects of such interactions on the relative fitness of wild spawners are not known. Efforts are underway to minimize negative impacts of hatcheries in the Upper Columbia River through improved broodstock management and selective fishing techniques.

4.2.2 ALTERNATIVE 1

Under Alternative 1, the three Mid-Columbia River hydroelectric projects would operate according to existing FERC license articles, settlement agreements, and interim stipulations. Long-term operational plans would continue to be implemented through existing coordinating committee protocols. The existing settlement agreements stipulate prescriptive measures to mitigate and compensate for the loss of anadromous fish habitat and production due to reservoir inundation, as well as losses associated with anadromous fish passage (juvenile and adult) at the projects. These agreements identify mitigation and enhancement measures, but do not contain specific survival rates or recovery goals for any species.

Protection measures under Alternative 1 include:

- Measures that allow for efficient upstream passage of adult fish through fishways and reservoirs and decreased fish injury and pre-spawning mortality. Examples include hydraulic and structural fishway improvements; specifically, ladder modifications and improved attraction flow to help move fish more quickly into the ladder systems and over the dams.

- Measures that provide downstream passage of juvenile salmonids while minimizing fish injury. Examples are spill and predator control programs.

These measures would be applied at the projects and do not include offsite compensation, such as tributary habitat improvements. Furthermore, these mitigation measures are intended to benefit all anadromous fish species more or less equally, with no specific additional measures implemented for Endangered Species Act-listed species. Implementation and monitoring would be conducted through the Mid-Columbia Coordinating Committee for Rocky Reach, and through the Wells and Rock Island coordinating committees for those projects.

4.2.2.1 Threatened and Endangered Species

The cumulative effects associated with the operation of the Mid-Columbia River projects were assessed in the QAR (NMFS 2000c draft). The report summarizes available information for Endangered Species Act listed Upper Columbia River steelhead and spring-run chinook salmon, reviews alternative approaches to estimating the risks of extinction and recovery perspectives, and provides preliminary estimates of the relative risks of extinction under a range of alternative management and climate and environmental scenarios. The QAR also provides analyses of the potential survival improvements that could be gained throughout the life-cycle of listed Upper Columbia River salmonids from hydropower system modifications, enhanced habitat, and changing climate and environmental conditions (i.e., ocean survival). Based on the analyses contained in this report, Upper Columbia River spring-run chinook salmon and steelhead have a high likelihood of going extinct (i.e., greater than a 95 percent chance within the next 100 years) if the current survival rates (1982 – 1996 juvenile passage years) continue into the future (refer to section 4.1). Continuing the status quo, as proposed under Alternative 1 is unlikely to appreciably change this conclusion.

Juvenile Migration/Survival

Protection and recovery measures for fish species listed under the Endangered Species Act would be the same as the mitigation and enhancement measures implemented for unlisted species under Alternative 1.

Wells Dam

Under Alternative 1, the Douglas County PUD would continue to operate the Wells Dam in accordance with the 1990 Wells Settlement Agreement (FERC 1991). The juvenile mitigation measures include:

- minimizing turbine unit and spill gate maintenance during the juvenile outmigration period, and
- operating the surface bypass system 24 hours a day during the period that encompasses 95 percent of the downstream.

Survival is typically higher for fish that pass through the bypass system (greater than or equal to 98 percent) than through the turbines (about 91.2 percent). Therefore, increasing the proportion of fish that use the bypass system results in improved juvenile dam survival. According to hydroacoustic studies conducted between 1990 and 1992, the Wells bypass system attracts about 92 percent of the spring migrants (Skalski 1993). This fish passage efficiency level results in a juvenile dam passage survival estimate of about 97.5 percent (92 percent passage efficiency times 98 percent survival, plus 8 percent turbine passage times 91.2 percent survival).

The juvenile fish mitigation measures implemented under Alternative 1 are expected to be similar to the protection and enhancement measures proposed for the other action alternatives. Given the existing survival study data, the 95 percent survival standard established for the HCPs would likely be met for all three alternatives at the Wells Dam.

Rocky Reach Dam

Under Alternative 1, the Chelan County PUD would continue to operate Rocky Reach Dam in accordance with measures prescribed in the existing FERC license (FERC 1957a, 1957b, 1968), or developed through the Mid-Columbia Coordinating Committee as part of the interim stipulations (FERC 1996b). Additional measures are also expected to be required during relicensing. The mitigation measures likely to occur under Alternative 1 include:

- operate the turbines within normal efficiency bands and continue to replace old turbine runners with new reduced-gap runners;
- continue to refine components of the surface bypass system to improve efficiencies and reduce injury/descaling rates;
- construct a permanent bypass outfall at a location that minimizes predation potential;
- provide spill equaling 15 percent of the previous day's total river flow for 36 days during the spring, with an additional 6 days of spill if necessary to encompass 90 percent of the Okanogan River sockeye salmon migration, and spill 10 percent of the previous day's average flow in the summer for 34 days between June 15 and August 15; and
- continue to implement predator control programs.

These mitigation measures are expected to improve fish passage efficiency for juvenile fish at the Rocky Reach Dam, particularly with respect to surface bypass system development. It is assumed that continued refinement of the bypass system would result in survival rates for spring-run chinook salmon and steelhead that are similar to those observed in the bypass systems at the lower Snake River dams (about 98 percent). Because of the configuration of the dam (which forms a cul-de-sac on the powerhouse side of the river), most of the fish that pass through the bypass would otherwise likely pass through the turbines, which have a lower survival rate (estimated at about 91.2 percent). The bypass system offers an alternative passage route for juvenile fish, which tend to accumulate at the downstream end of the cul-de-sac (near Turbine Units 1-3).

Although spillway survival is usually expected to be the same or slightly higher than bypass survival, the Rocky Reach spillway is not particularly effective at the lower spills implemented to date. From 8 to 19 percent of the fish are typically passed in 15 percent spill (Steig and Adeniyi 1997; English et al. 1998c, 1999). Other mainstem Columbia and Snake River dams typically achieve much higher spill to fish passage ratios at this spill volume. The apparent inefficiency of the Rocky Reach spillway is believed to be associated with the configuration of the dam. Juvenile fish that enter the cul-de-sac (adjacent to the powerhouse) tend to pass the project through the bypass system or the turbine units rather than moving back upstream to the spillway.

The survival estimates developed as a result of PIT-tag evaluations conducted in 1998 and 1999 represent the best available information regarding both the direct and indirect effects of the Rocky Reach Hydroelectric Project on the survival of juvenile spring-run chinook salmon and steelhead. These studies indicate that juvenile spring-run chinook salmon survival ranges between approximately 72.8 percent and 118.7 percent ([weighted average = 85.9 percent], based on total project survival evaluations conducted on hatchery reared yearling fall-run chinook salmon in 1998 [Eppard et al. 1999]). Survival estimates for steelhead ranged from 87.9 percent to 111.9 percent ([weighted average = 95.9 percent] based on an analysis of the information collected by the Douglas County PUD on hatchery reared steelhead [Bickford et al. 2000]). The information also indicates that survival is higher through the spillway and bypass system than through the turbine units. Survival estimates are required for all species, over a variety of river flow and project operational conditions to reliably assess project-related mortality rates, and future studies could demonstrate different survival rates than those recently observed.

Despite the improvements in juvenile fish passage efficiency, additional protection and enhancement measures could be implemented at the project to improve the survival of listed species. Under Alternative 1 however, there is no requirement to implement these additional measures. As a result, Alternative 1 is expected to result in lower survival for the listed species compared to the expected survival that would likely result under Alternatives 2 or 3.

Rock Island Dam

Under Alternative 1, the Chelan County PUD would continue to operate Rock Island Dam in accordance with the existing FERC settlement agreement (FERC 1987b) and license articles (FERC 1989b). Currently, the primary methods for maximizing juvenile spring-run chinook salmon and steelhead survival at the Rock Island Dam is through spill and predator control measures. The existing spill program has developed as a result of provisions in the Rock Island settlement agreement and is based on a conservation account of $2.05 million (1986 dollars adjusted for inflation).

The predator control program includes removal of northern pikeminnow from the forebay and tailrace, predatory bird hazing, and gull wires strung across the tailrace. Between 1995 and 1998, over 26,600 predatory northern pikeminnow were removed from the vicinity of Rock Island Dam under this program. The predator control program is expected to result in a significant reduction in predation rates on migrating salmon and steelhead smolts.

Mitigation measures that are expected to continue under Alternative 1 include:

- providing daily average spill levels as requested by the fishery agencies and Tribes through the Fishery Conservation Account, and
- evaluating spillway modifications to increase spill effectiveness,

These mitigation measures are expected to maintain current juvenile fish passage survival rates at the Rock Island Dam.

The survival estimates developed as a result of PIT-tag evaluations conducted in 1998 and 1999 represent the best available information regarding both the direct and indirect effects of the Rock Island Dam on the survival of juvenile chinook salmon and steelhead. These studies indicate that juvenile spring-run chinook salmon survival is between approximately 62.4 and 135.6 percent ([weighted average = 89.3 percent], based on total project survival evaluations conducted on hatchery reared yearling fall-run chinook salmon in 1998 [Eppard et al. 1999]), and juvenile steelhead survival is between approximately 84.6 and 110.8 percent ([weighted average = 95.8 percent], based on total project survival evaluations conducted on hatchery reared juvenile steelhead in 1999 [Stevenson et al. 2000]). Direct juvenile salmonid survival estimates calculated at the spillway and powerhouses, although not conclusive, are consistent with the trends identified in the PIT-tag survival evaluations.

Implementing the measures under Alternative 1 does not allow for the continued evaluation of project effects on listed species and, from the limited data currently available, does not result in sufficiently high survival to ensure the continued existence of spring-run chinook salmon. Without continued research and evaluation, and improved passage survival measures, Alternative 1 is expected to result in lower long-term survival for listed species than either Alternatives 2 or 3.

Adult Migration/Survival

The Douglas and Chelan County PUDs operate three of the five non-Federal Mid-Columbia River hydroelectric projects. Upper Columbia River spring-run chinook salmon and steelhead from the Methow and Okanogan rivers must pass all five of these dams to reach their spawning grounds. The Entiat River fish runs must pass four Mid-Columbia River dams, and the Wenatchee River fish runs must pass three of these dams. Although Mid-Columbia River steelhead do not migrate past any of the five Mid-Columbia River projects, they are subject to variations in flow and other water quality issues that result from project operations. Although the combined effects of all five projects on each of these species are unknown at this time, many of the effects are likely cumulative.

The direct mortality of adults passing individual projects is likely minimal under normal operating conditions. However, each dam presents the potential for migration delays, increasing energy expenditure as fish move through the fishladders, increasing incidences of involuntary fallback through the dam, and increasing exposure to high concentrations of dissolved gases. Increased migration rates though the relatively slack water reservoirs may, however, counteract some of these effects.

The impacts (positive or negative) and magnitude of the cumulative effects to adult anadromous fish are largely unknown at this time and the uncertainty surrounding the information regarding these effects cannot be overstated.

Adult passage information, such as the time spent immediately downstream of the dam, success at passing into the collection channel and fishway entrances, and time spent passing through the ladders are typically assessed using radio-telemetry techniques. Although previous studies have not been able to determine a direct relationship between project passage times and reproductive success, reducing passage times is expected to reduce energy expenditures and improve the likelihood that adult fish will survive to spawn.

Radio-telemetry studies only provide information for tagged fish that pass the project. Failure to pass a project may result from poorly designed passage facilities, inadequate attraction water, or complicated flow patterns resulting from project operations. In addition, fish that fail to pass a project could be destined for downstream spawning areas or may have been injured previously during their upstream migration. Tagging effects or regurgitated tags can also effect the study results but are not related to project operations.

There is very little data available to assess the survival of adult anadromous salmonids passing the

Mid-Columbia River projects. Radio-telemetry evaluations conducted between 1993 and 1998 contain the bulk of the available data, but survival was not specifically addressed in any of these studies.

Project operations are not expected to directly affect adult migrations in tributary streams. However, migration delays or injuries resulting from project passage could potentially reduce the ability of fish to reach their natal spawning grounds. Typical reservoir water level fluctuations are not expected to impact the ability of adult fish to enter the mainstem tributaries. If reservoir drawdown was implemented to improve juvenile survival, access to these tributaries by upstream migrating adults may initially be limited due to alluvial sediments that have accumulated at the confluences to the mainstem Columbia River.

The effects of project operations on migratory bull trout are unknown, although adult bull trout have been observed using the adult fishways. It is reasonable to assume that some portion of the adult bull trout populations pass through the turbines and spillways, either voluntarily or involuntarily, given their presence in the project area and use of project fishways. The dams can also present a partial migration barrier that can lead to isolated or semi-isolated populations, which are generally considered less genetically fit to withstand habitat or population disturbances. The overall extent or severity of these impacts is unknown, and further studies would be needed to evaluate the potential impacts.

Wells Dam

As mitigation for adult spring-run chinook salmon and steelhead under Alternative 1, the Douglas County PUD would:

- maintain and operate adult passage facilities at the project according to criteria stipulated in the 1990 Wells Settlement Agreement (FERC 1991);
- investigate entrance and ladder modifications to improve ladder operations with specified criteria and minimize delays;
- operate the spill and turbine units in a manner that optimizes the attraction flows at the fishway entrances and improve adult passage, while meeting requirements for juvenile fish passage; and
- conduct fish passage studies to identify and correct potential problems.

These measures were developed to minimize the effects of project operations on adult passage.

Radio-telemetry studies indicate that the median passage time for adult spring-run chinook salmon at the Wells Dam is similar to that observed at other Mid-Columbia River projects. However, passage times for steelhead appear to be substantially faster than for spring-run chinook salmon or other anadromous fish species. Overall, the majority of the passage delays at the project were associated with the collection channel (Stuehrenberg et al. 1995), although the effects of the adult brood traps in the Wells fishladders likely influenced these study results. Trap operations increased the total project passage times by 5 to 10 times over those observed during non-trapping periods (English et al. 2000). Despite the apparently faster passage of steelhead at the project, the Okanogan River bound steelhead may be experiencing some delay in the Wells Project reservoir (at the mouth of the Okanogan River). However, there is only indirect information that indicates that these factors may be affecting overall spawning success and the effects seem to be associated with warmer water being discharged from the Okanogan River.

There is little information to suggest that substantial injuries are occurring to adult fish passing through the fishladders under normal operating conditions. Therefore, the greatest potential for injury and mortality to adult fish is believed to be associated with fallback. Although the fallback rate for spring-run chinook salmon is relatively low, there is no data to determine the effect on survival. There is also no steelhead fallback data or information specific to kelt passage. (For additional information refer to section 3.2.5.)

Rocky Reach Dam

Mitigation measures for adult spring-run chinook salmon and steelhead under Alternative 1 would include maintaining and operating the adult passage facility according to criteria in the existing FERC license and subsequent stipulations. Evaluations have shown that at least 80 percent of the sockeye and summer-run chinook salmon passage delay occurs in the fishway entrance pools. It is likely that similar delays occur in this area for spring-run chinook salmon and steelhead as well (see Section 3.2.5), although there is only indirect information that indicates that these factors may be affecting overall spawning success.

There is little data to assess the survival of adult salmon and steelhead or steelhead kelts passing downstream through the juvenile bypass system. However, it is likely that survival through the bypass is higher than through the turbine units.

Rock Island Dam

Under Alternative 1, the Chelan County PUD would maintain and operate the adult passage facilities at the project according to criteria included in the existing FERC license and settlement agreement. The effects of these actions on adult fish are similar to those described for the Rocky Reach Dam (see Section 3.2.5).

Adult Reservoir Spawning

There is no available information indicating that substantial adult spring-run chinook salmon or steelhead spawning occurs in the Wells, Rocky Reach, or Rock Island reservoirs, although some steelhead spawning might occur in the tailraces (similar to summer/fall-run chinook salmon) or at the mouths of the Wenatchee and Chelan rivers. The operation of the Wells, Rocky Reach, and Rock Island powerhouses may have some effect on the steelhead spawning.

Although bull trout are occasionally observed in the project areas, they are generally believed to spawn in small headwater tributaries. Therefore, project operations are only expected to affect bull trout spawning for those fish that migrate past each dam. However, the potential effects are unknown at this time.

Tributary Habitat Improvements

Under Alternative 1, the PUDs would not fund habitat-related mitigation for adult spawning and juvenile rearing in the Mid-Columbia River tributary streams. As with the other two alternatives however, some tributary habitat improvement projects are expected to occur through funding sources other than the PUDs.

Hatchery Production

The hatchery programs currently supported by the Chelan and Douglas County PUDs were developed to mitigate for the loss of spawning habitat with the inundation of the mainstem Columbia River by the project reservoirs, and for estimated losses associated with fish passage at the projects. Under Alternative 1, these facilities would likely continue to be funded by the PUDs and operated by the WDFW or the Colville Tribe in accordance with policies and guidelines of the State and Section 10 permits issued under the provisions of the Endangered Species Act. The Section 10 permits describe the efforts implemented to avoid and minimize the effects that hatchery reared fish may have on Endangered Species Act-listed salmonids. These efforts include protocols for adult collection and spawning, rearing and release strategies, fish health management programs and environmental monitoring. These protocols are expected to be followed for all hatchery stocks and would equally benefit non-listed fish species.

Wells Dam

Under Alternative 1, the Douglas County PUD would continue to fund the current hatchery compensation programs for spring-run chinook salmon at the Methow Fish Hatchery, and for steelhead at the Wells Hatchery and off-site acclimation facilities according to stipulations in the 1990 Wells Settlement Agreement (FERC 1991). Operation of the Wells Hatchery program has previously received a Section 10 permit (#1094, issued to WDFW on February 4, 1998) and a biological opinion concerning NMFS' issuance of the permit has been completed. Operation of the Methow Fish Hatchery is currently being considered in the review of Section 10 permit (#1196 to WDFW) and a biological opinion is in preparation concerning NMFS' issuance of that permit. Therefore, Endangered Species Act requirements would be satisfied for the PUD-funded hatchery compensation program under Alternative 1.

The Methow and Wells hatcheries were established as part of the 1990 Well Dam Settlement Agreement and were intended to compensate for an assumed total project mortality rate of 14 percent (including reservoir and dam passage). However, recent juvenile survival studies suggest that the current hatchery compensation level is greater than the apparent fish losses resulting from dam passage. Under Alternative 1, the compensation levels could be adjusted to reflect the actual fish passage losses, according to stipulations in the Wells Settlement Agreement (FERC 1991).

Since inception in 1992, the Methow Hatchery has been operating under a supplementation strategy. Under this program, the genetic integrity of the Methow River chinook stock supercedes the hatchery production goals established in the 1990 Wells Settlement Agreement. As a result, current management objectives and hatchery criteria have reduced the production levels by about 25 percent compared to the goals established in the settlement agreement (Douglas County PUD 1999a). The hatchery program also includes the development of spring-run chinook salmon broodstock management protocols and the volitional release of smolts from acclimation ponds located in tributary streams.

Rocky Reach Dam

The Turtle Rock and Chelan Falls hatchery facilities are owned by the Chelan County PUD and operated by the WDFW in accordance with Section 10 permit #1094 (issued to WDFW). A biological opinion concerning NMFS' issuance of that permit has been completed. The Section 10 permit describes efforts made by the agency to avoid and minimize impacts to listed species (similar to those describe previously). Therefore, there are no additional impacts on spring-run chinook salmon and steelhead associated with the hatchery compensation program.

Under Alternative 1, the Chelan County PUD would continue to fund the operation and maintenance of these hatcheries at a level equivalent to the 1996 budgeted operation and maintenance costs, adjusted annually for inflation. The existing production capacities are believed to compensate for juvenile fish passage losses and for original inundation behind Rocky Reach Dam. The hatchery program would likely continue to be operated by WDFW, in a manner consistent with the recovery of spring-run chinook salmon and steelhead populations.

Rock Island Dam

The East Bank and Chiwawa hatchery facilities are owned by the Chelan County PUD and operated by the WDFW. The spring-run chinook salmon programs are currently being considered in the review of Section 10 permit #1196 (issued to WDFW). A biological opinion concerning NMFS' issuance of that permit is in preparation. The Section 10 permit requirements are similar to those described previously. Therefore, there are no additional impacts on spring-run chinook salmon and steelhead associated with the hatchery compensation program.

Under Alternative 1, the Chelan County PUD would continue to fund the operation and maintenance of these hatcheries at a level equivalent to the 1998 budgeted operation and maintenance costs, adjusted annually for inflation. The existing production capacities are believed to compensate for juvenile fish passage losses and for original inundation behind Rock Island Dam. The hatchery operation protocols are similar to those described previously for Rocky Reach Dam.

Associated Tributaries

Impacts associated with hatchery supplementation in the Mid-Columbia River tributaries include the potential interactions between hatchery and wild stocks (competition, predation, and disease transmission), and the potential changes or alterations to the genetic integrity and diversity of both populations. Competition between hatchery and wild juvenile fish may occur where food and space requirements overlap or are limited. However, there is little information to document the magnitude or significance of these potential interactions in the Mid-Columbia River region.

There is also little information on the potential predation of hatchery fish on wild fish, although the typical size difference between hatchery and wild fish suggests that such interactions are possible. Although the transmission of diseases from fish to fish (horizontal transmission) can occur in hatcheries or other areas where affected and non-affected fish are held in close contact, there is little data that suggests that this is a significant problem in the riverine environment. All three of these potential interactions would be greatest at or near the hatchery release points, and would be expected to decrease over time and space.

The potential risk of changing the genetic integrity and diversity of wild and hatchery fish populations would be minimized by the utilization of appropriate hatchery management practices. The current strategies of the Mid-Columbia River hatchery program were developed to be consistent with the NMFS interim policy on artificial propagation under the Endangered Species Act. Therefore, no additional impacts are expected from the Mid-Columbia River hatchery programs.

Monitoring and Evaluation

Under Alternative 1, the PUDs would continue to implement the research and monitoring plans identified in the license articles, settlement agreements, and interim stipulations. The primary purpose of these plans is to ensure that the mitigation measures being implemented under the existing licenses are achieving the intended results, to further refine the juvenile bypass system (at Rocky Reach), and to improve adult passage (Wells Dam).

Wells Dam

Under Alternative 1, the Douglas County PUD would conduct the following monitoring and evaluation measures:

- Continue to assess juvenile run timing at the Wells Project with real-time hydroacoustic monitoring, and to verify these data with fyke-net evaluations.
- Evaluate juvenile survival through the project using the best available techniques, that may include the use of radio-telemetry or other tag release and recapture methodologies. These methods would be developed through consultation with the Wells Coordinating Committee.
- Evaluate potential problems associated with the project fishways to minimize potential delays or pre-spawning mortality.
- Provide adult fish counts on a 24-hour basis.

Rocky Reach Dam

Under Alternative 1, the Chelan County PUD would conduct the following monitoring and evaluation measures:

- Continue to assess juvenile run timing using the juvenile fish bypass sampler.
- Assess the injury, mortality, and descaling of juvenile fish passing through the bypass system.
- Provide adult fish counts on a 24-hour basis.

Rock Island Dam

Under Alternative 1, the Chelan County PUD would conduct the following monitoring and evaluation measures:

- Continue to assess juvenile run timing using the Powerhouse 2 juvenile fish sampler.
- Monitor the condition of fish passing through the bypass for injury, mortality and gas bubble disease rates.
- Continue to evaluate spillway modifications to improve juvenile fish passage efficiency.
- Provide adult fish counts on a 24-hour basis.

Columbia River System

A discussion of the cumulative effects associated with the operation of the Mid-Columbia River hydroelectric projects on the Endangered Species Act-listed fish species is provided in Section 4.1 and is based on the QAR analyses. These analyses suggest that the Mid-Columbia River projects under Alternative 1 (including dam removal) would not meet the extinction and recovery criteria unless accompanied by substantial improvements in the overall life-history survival conditions.

4.2.2.2 Other Anadromous Species

Alternative 1 provides the same level of protection for all anadromous fish species, regardless of their listing status under the Endangered Species Act. The protection criteria are based primarily on project operational guidelines rather than survival rate criteria.

Juvenile Migration/Survival

Wells Dam

The effectiveness of the Wells Dam juvenile fish protection measures for non-Endangered Species Act-listed species, provided by Alternative 1, would continue to be evaluated primarily through fish passage efficiency criteria. Fish passage efficiency is defined as the ratio of fish that pass the project through non-turbine routes to the total fish that pass the project. The fish passage efficiency criteria were developed because of the limited availability of survival data, and the fact that turbine passage survival is substantially lower than non-turbine passage. The fish passage efficiency criteria, established in the 1990 Wells Settlement Agreement, are set at 80 percent for spring migrants, and 70 percent of summer migrants (FERC 1991).

According to hydroacoustic evaluations conducted between 1990 and 1992, the Wells bypass system has an average fish passage efficiency of 92 percent for all spring migrants, and 96 percent for all summer migrants (Skalski 1993). Therefore, the established passage efficiency criteria are being met under existing conditions. In addition to meeting these criteria, the overall survival for the non-listed anadromous species are expected to be similar to those discussed for the listed species. Therefore, dam passage survival is expected to be similar for all the alternatives at the Wells Dam.

Rocky Reach Dam

Under Alternative 1, the Chelan County PUD would continue to operate Rocky Reach Dam in accordance with the existing FERC license and interim stipulations.

The Rocky Reach dam juvenile fish protection procedures are primarily prescriptive in nature, with no specific performance (i.e., survival) goals. The main goal of the juvenile fish protection measures at Rocky Reach Dam for non-listed species is to develop a safe (less than 2 percent mortality) bypass system capable of passing 80 percent of the juvenile migrating salmon and steelhead over 90 percent of the migration period. Prior to the development of the bypass system, the Chelan County PUD would provide interim protection of juvenile migrants through the use of spill.

Although the mitigation measures for Rocky Reach Dam are not based on survival rates, they can be estimated to allow comparisons between the EIS alternatives. In lieu of specific survival data for each anadromous fish species passing the Rocky Reach Dam, all the available dam-specific data (as well as data from other projects in the Columbia River basin) were used to estimate survival for each species. Based on the available information, juvenile fish dam passage survival ranges from 92.5 to 95.9 percent (see Table 3-3).

Rock Island Dam

Under Alternative 1, the Chelan County PUD would continue to operate Rock Island Dam in accordance with their existing FERC license and the Rock Island Settlement Agreement (FERC 1987b). The primary method for maximizing juvenile anadromous fish survival at the Rock Island Dam is through spill. Spill passage is believed to be the most benign passage route for most species (Chapman et al. 1994a). The spill program would be implemented based on the conservation account described previously (Section 4.2.2.1 under Juvenile Migration/Survival).

Similar to the juvenile fish mitigation measures for non-listed species described for the Rocky Reach Dam, the mitigation programs at the Rock Island Dam are prescriptive, and do not include survival goals. For the purposes of comparing alternatives, however, survival under Alternative 2 can be estimated.

Based on available information, juvenile salmonid survival for all species passing the Rock Island Dam is expected to range between 89.3 and 93.9 percent (see Table 3-3). Eppard et al. (1998) estimated reservoir and dam passage survival at 89.3 percent for hatchery reared yearling fall-run chinook salmon (a surrogate for yearling spring-run chinook salmon). A similar study conducted in 1999 with hatchery steelhead estimated survival at 95.8 percent (Stevenson et al. 2000). Survival for the remaining species was calculated based on the available (on-site and off-site) route specific information. They ranged from 92.6 percent for sockeye to 93.9 percent for fall-run chinook salmon.

Adult Migration/Survival

Several radio-tag studies indicate that the adult fishways at the Mid-Columbia River dams are generally effective at providing passage for anadromous adult fish under normal operating conditions, although passage times for fall- and summer-run chinook salmon appear to be longer than for spring-run chinook salmon and steelhead (see Table 2-4). Summer- and fall-run chinook salmon are also likely to be more vulnerable to delays because their migrations extend further into the summer when water temperatures are higher. Higher temperatures increase the fish's metabolic rate resulting in greater energy expenditures. Their migration period also tends to be closer to their spawning periods, allowing less time to compensate for migration delays. Although these factors might be increasing the rate of pre-spawning mortality for some of the anadromous species, there is no data to quantify the impacts.

The adult fishways at the PUD projects are operated according to criteria established in existing FERC licenses, settlement agreements, and interim stipulations.

Wells Dam

Radio-telemetry evaluations at the Wells Dam indicate that summer- and fall-run chinook salmon experience passage delays negotiating the collection channel and entering the ladder (see Table 2-4). However, recent modifications to ladder operations have indicated a substantial reduction in the passage times of adult summer- and fall-run chinook salmon. Closing the side entrances to the ladder resulted in passage time reductions from 52.5 to 20.6 hours in 1997 and from 38.5 to 19.0 hours in 1998. Additional studies will be conducted in 2001 to verify the effects of closing the side entrances. There is no indication that sockeye salmon experience substantial delays passing the project. Although there are no known direct sources of mortality to adult salmonids at the Wells Dam under normal operating conditions, mortality could occur as a result of fallback through the spillway, bypass or turbine units. However, the magnitude of the effects is unknown.

Under Alternative 1, the Douglas County PUD would maintain and operate adult passage facilities in accordance with the 1990 Settlement Agreement (FERC 1991). The Douglas County PUD would also continue to operate spill and turbine units in a manner that optimizes adult passage, while meeting requirements for juvenile fish passage. The implementation of these plans is expected to minimize the impacts to adult fish passing the project. These operations are expected to be similar for all three alternatives.

Rocky Reach Dam

Under Alternative 1, the Chelan County PUD would maintain and operate adult passage facilities according to the existing FERC license and interim stipulations. As with the fishways at the Wells Dam, there is evidence to suggest that sockeye and summer-run chinook salmon experience passage delays in the fishway entrance pools of the Rocky Reach fishway. However, there is no data to suggest any direct injury or mortality resulting from fish passage under normal operating conditions (Refer to section 3.2.5 for more information.)

Rock Island Dam

Under Alternative 1, the Chelan County PUD would maintain and operate adult passage facilities in accordance with the existing FERC license and settlement agreement. The potential problems associated with passage through these fishways are attributed to delays in locating the entrances, and in the junction pools. However, the available data suggest that passage conditions at Rock Island Dam are better than at either the Rocky Reach or Wells dams (Refer to section 3.2.5 for more information.).

Adult Reservoir Spawning

No direct effects of project operations on sockeye salmon spawning are expected because sockeye tend to spawn well upstream of the projects in streams associated with Lake Wenatchee and Lake Osoyoos. Summer/fall-run chinook salmon however, are expected to exhibit substantial spawning activity in the Mid-Columbia River reservoirs. However, the spawning habitat is primarily restricted to upper reservoir or tailrace areas. The potential project operations related impacts include: deposition of fine sediments that may reduce incubation and spawning success, scour or relocation of gravel near the tailraces, and fluctuations in pool elevation. Total dissolved gas levels resulting from spill at the projects may increase stress levels in migrating fish and may potentially result in an increased incidence of pre-spawning mortality. However, the deep-water spawning areas are expected to provide sufficient refuge from these dissolved gas levels during the spawning process. The potential impacts to reservoir spawning species is not expected to differ from existing conditions due to the projects limited ability to control river flows.

Hatchery Production

As discussed previously, the hatcheries funded by the Chelan and Douglas County PUDs are operated by the WDFW and Colville Tribe in accordance with policies and guidelines of the State and Section 10 permits issued under the provisions of the Endangered Species Act. The strategies of incorporating natural broodstocks into the artificial production program is expected to strengthen the natural spawning populations and improve the genetic diversity in the hatchery stocks. These changes in the hatchery programs might result in a reduced number of total hatchery fish produced in the short-term, particularly for diminished stocks that cannot support broodstock programs, although (in the long-term) should result in stronger and healthier stocks throughout the region. Potential impacts to the anadromous species related to the hatchery programs are expected to be similar to those discussed previously (Section 4.2.2.1 under Hatchery Production).

Tributary Habitat Improvements and Monitoring

The previous discussions of tributary habitat improvements and monitoring programs related to the Endangered Species Act-listed stocks are also applicable to the non-listed species under Alternative 1 (Section 4.2.2.1 under Tributary Habitat Improvements).

4.2.2.3 Resident Fish Species

Project Areas

Little is known about the affects of project operations on resident fish population in the Mid-Columbia River. In general, the most important effects are related to spawning success, early survival of juveniles, and food supply. Typically the most substantial influence on all of these issues is the fluctuation in water levels related to hydroelectric project operations. Because all of the Mid-Columbia River PUD projects are run-of-river dams, they have limited ability to control these levels. Normal reservoir fluctuations are minor, ranging from 3 to 10 feet. The reservoirs are generally narrow, with relatively steep banks, so these water level fluctuations have limited influence on the wetted area of the river. The minor exceptions are the shallow bar areas associated with tailraces, the mouths of tributary streams, and the occasional backwater or off-channel ponds.

The Wells reservoir is larger and shallower than the other reservoirs and the water level fluctuations are greater. Therefore, the effects of water level fluctuations are also greater at the Wells Dam and are more prone to influence resident fish populations. This is particularly true in the relatively wide and shallow area near the mouth of the Okanogan River (Brewster Flats). Drawdown would likely result in a greater decrease in habitat for resident fish in the Wells reservoir than in the other two reservoirs. However, there is little information on resident fish population sizes and population trends in any of the reservoirs to quantify the actual effects of water level fluctuations or other project operations.

Under Alternative 1, predator control programs would continue to be implemented. These activities would also have substantial effects on resident fish populations in the reservoirs. The programs target the removal of northern pikeminnow, which have been shown to be the most significant fish predator on juvenile salmonids in the basin. When salmonid smolts are not migrating downstream, however, the northern pikeminnow diet consists of a greater proportion of non-salmonid prey, as well as an increase in non-fish species. Predator reductions would result in the increased survival of salmonid smolts passing the projects, as well as increased numbers of other resident fish species in the reservoirs.

Other anadromous or migratory species that occur in the Mid-Columbia River area are white sturgeon, and Pacific lamprey.

Pacific Lamprey

Lamprey are a migratory species and pass the Mid-Columbia River projects through all available routes. There is no specific information concerning the mortality rates of this species passing the projects, although they are particularly susceptible to impingement on turbine intake diversion screens. The only screens that are currently in operation at the Mid-Columbia River dams are at turbine units one through three at the Rocky Reach Dam. These screens were installed to increase the efficiency of the bypass system, although additional screens are currently not planned for future installation. Substantially fewer fish pass through the turbine units that are currently unscreened, so fewer fish are available for diversion with additional screens. Turbine intake screens are currently not being used at Rock Island Dam, although previous evaluations suggest guidance efficiencies of about 75 percent could be obtained at Powerhouse 1 for yearling chinook salmon and steelhead.

White Sturgeon

Little is known about the population levels of white sturgeon in the Mid-Columbia River region. The mainstem dams present substantial migration barriers to this species because they do not readily use fishladders. Therefore, the populations of sturgeon in the Mid-Columbia River are considered to be isolated or semi-isolated populations. Isolated fish populations are generally considered less genetically fit to withstand habitat or population disturbances, although the overall extent or severity of these impacts is unknown.

Associated Tributaries

Project operations under Alternative 1 would not alter tributary habitat or resident fish populations that occur there. However, migratory species that move between the tributary and reservoir areas might be affected by project operations, as discussed previously. In addition, hatchery fish planting activities would result in temporary increases in competition for habitat and food resources with resident species. The extent of this competition or the effects on resident fish populations is currently unknown. The increased use of volitional release strategies for hatchery fish from acclimation ponds would reduce the densities of hatchery fish in the tributaries and minimize the potential negative interactions with resident fish. Under these strategies, hatchery fish leave the ponds when they are ready to begin their downstream migrations and are therefore unlikely to spend much time in the tributaries.

Columbia River System

With the possible exception of increased total dissolved gas levels resulting from spill at the projects, project operations have little effects on resident populations in the lower Columbia River. The resident fish in the basin tend to occur in discrete populations bounded by the hydroelectric projects and the accessible areas of tributary streams. Although there are opportunities for fish to move between these populations, this movement might be greater in a downstream direction as a result of the involuntary entrainment in water passing the dams. Upstream fish movements require a voluntary behavior characteristic within the populations, and do not occur inadvertently. The downstream displacement of resident fish might also occur during high flow spill periods under existing conditions.

Although there is some data concerning the abundance of resident fish populations in the system, there is little or no information concerning hydroelectric project operations on the interactions between populations.

4.2.3 ALTERNATIVE 2

Under Alternative 2, the Wells, Rocky Reach, and Rock Island hydroelectric projects would be operated according to existing FERC licenses, settlement agreements, and interim stipulations as modified by NMFS' biological opinions for listed species. These biological opinions would specifically address two fish species listed under the Endangered Species Act (spring-run chinook salmon and steelhead). If additional anadromous fish species were listed under the Endangered Species Act, protection from the Section 9 take prohibitions would be addressed independently.

The existing FERC licenses, settlement agreements, and interim stipulations include measures to mitigate for the loss of anadromous fish habitat and production due to reservoir inundation, as well as losses associated with anadromous fish passage (juvenile and adult) at the projects. As discussed under Alternative 1, listed species have a high likelihood of extinction under these measures alone. All measures necessary to aid in the recovery of listed species, up to full mitigation for the project effects, would be considered under Alternative 2 (the Section 7 consultation process).

4.2.3.1 Threatened and Endangered Species

The QAR (Quantitative Analytical Report – NMFS 2000c draft) summarizes available information for Endangered Species Act listed Upper Columbia River steelhead and spring-run chinook salmon, reviews alternative approaches to estimating the risks of extinction and recovery perspectives, and provides preliminary estimates of the relative risks of extinction under a range of alternative management and climate and environmental scenarios. Although specific survival requirements have not been established under Alternative 2, beyond maximizing survival as necessary to aid in the recovery of listed species, the QAR analyses indicate that survival would increase from between 116 to 135 percent of current levels (1982 – 1996 juvenile passage years) by achieving the 95 percent juvenile dam passage survival standard in the HCPs (refer to section 4.1).

Measures implemented under Alternative 2 are expected to meet the HCP juvenile dam passage survival standards at a minimum, and additional measures would be implemented if higher levels were required to aid in the recovery of listed species.

Juvenile Migration/Survival

The effectiveness of protection and recovery measures for spring-run chinook salmon and steelhead, listed under the Endangered Species Act, would be based on survival estimates at the projects, fish passage efficiency if direct estimates of survival were not available, and the long-term recovery status of the species. In general, survival goals are based on the analyses contained in the QAR. Conditions for the survival and recovery of the listed fish species are expected to be similar for both Alternatives 2 and 3, although the measures and implementation schedule necessary to reach or approach these conditions might be different for each of the alternatives. Alternative 2 would require all measures necessary to aid in the recovery of listed species, up to and including mitigation for the full project effects. These survival conditions would only apply to Endangered Species Act-listed species however, while other non-listed species would continue to be protected through current mitigation measures identified in the existing licenses and settlement agreements for each project.

Similar to Alternative 1, reservoir drawdown is a potential (although remote) protection measure for anadromous fish species under Alternative 2. However, this option could only occur as a result of relicensing procedures (the PUDs could propose drawdown during a license term as discussed in the HCPs). Rocky Reach is due for relicensing in 2006, while the relicensing of the Wells and Rock Island projects would occur in 2012 and 2028, respectively.

Drawdown could result in faster juvenile migration speeds due to higher water velocities, slightly lower water temperatures, increased turbidity, and potentially lower total dissolved gas levels. Although these results are expected to increase the survival of migrating juvenile fish over the long-term, the lower water levels would increase the density of predator fish and increase the incidence of predator/prey encounters in the short-term. Also in the short-term, if drawdown were initiated, turbidity and sedimentation would increase substantially over existing conditions.

A detailed site-specific evaluation and separate EIS would be required to determine the benefits and environmental affects of drawdown, under any alternative, before the measure could be implemented.

Wells Dam

Under Alternative 2, the Douglas County PUD would operate the Wells Dam in accordance with the existing license articles and settlement agreements, in addition to any modifications required as a result of Section 7 consultations. The other anadromous fish species would be protected through the 1990 Wells Settlement Agreement (FERC 1991).

The juvenile fish protection measures implemented under Alternative 2 would be similar to those already implemented (Alternative 1) and those proposed for Alternative 3, provided the species recovery status reflects improving population size over the long-term. If the population status does not improve, additional measures would be required.

Total project survival has been estimated at 99.7 percent for hatchery reared yearling spring-run chinook salmon (Bickford et al. 1999) and 94.3 percent for hatchery reared steelhead smolts (Bickford et al. 2000). Thus, the existing conditions meet the fish passage efficiency criteria established in the 1990 Wells Settlement Agreement, satisfy projected recovery goals established in the QAR, and suggest that the 95 percent survival criterion proposed in the HCP is also being met. Therefore, there would likely be no additional requirements to increase turbine survival or bypass efficiencies at Wells Dam under Alternative 2, unless new research demonstrated a need for higher survival goals.

Rocky Reach Dam

Under Alternative 2, the Chelan County PUD would continue to operate Rocky Reach Dam in accordance with the existing license articles and interim stipulation, in addition to any modification required as a result of Section 7 consultations. Although the Rocky Reach Fourth Revised Interim Stipulation (FERC 1996b) has expired, the other anadromous fish species would be protected by the continued implementation of measures established through that and previous stipulations, until this stipulation was either modified or superseded by a new license agreement.

The protection and enhancement measures proposed for Alternative 1 would continue, and are expected to increase the survival of juvenile fish passing the Rocky Reach Dam. It is assumed that continued refinement of the bypass system would result in survival rates for spring-run chinook salmon and steelhead that are similar to those observed in the bypass systems at the lower Snake River dams (about 98 percent for the proportion of fish utilizing this passage route). Until this level of survival was verified however, or if additional protection measures were needed to aid in the recovery of the listed species, spill would likely be increased at the Rocky Reach Dam.

Under Alternative 2, NMFS would determine the most appropriate survival goals and protection measures for the recovery of threatened and endangered species, and modify these survival goals as needed to ensure the recovery of the listed species.

A 1999 survival study estimated overall survival through the Rocky Reach reservoir and dam at 95.9 percent for hatchery reared steelhead smolts (Stevenson et al. 2000). Studies conducted in 1998 with hatchery reared yearling fall-run chinook salmon estimated survival at between 85.9 and 93.9 percent (Eppard et al. 1999; Bickford et al. 1999). Survival estimates are required over a variety of river flow and project operational conditions to reliably assess project-related mortality, and future studies could demonstrate different survival rates than those recently observed. If a consistent pattern of lower survival is demonstrated, the NMFS would impose additional protection measures.

Rock Island Dam

Under Alternative 2, the Chelan County PUD would continue to operate the Rock Island Dam in accordance with the FERC license and Rock Island Settlement Agreement (FERC 1989b), in addition to any modification required as a result of Section 7 consultations. A full discussion of the existing mitigation measures is provided in Section 4.2.2.1 under Juvenile Migration/Survival – Rock Island Dam. It is likely that NMFS would initially require increases in spill (associated with spillway structural modifications to reduce total dissolved gasses), followed by habitat improvement measures and any other measures necessary to aid in the recovery of listed species, up to full mitigation for the project effects.

Currently, the primary methods for maximizing juvenile spring-run chinook salmon and steelhead survival at the Rock Island Dam are through spill and predator control programs. The current spill program is implemented based on a conservation account of $2.05 million (in 1986 dollars). The predator control program includes the removal of northern pikeminnow from the forebay and tailrace areas, as well as predator bird hazing and gull wires strung across the tailrace. Between 1995 and 1998, over 26,600 predatory northern pikeminnow were removed from the vicinity of Rock Island Dam under this program. The predator control program is expected to result in a significant reduction in predation rates on migrating salmon and steelhead smolts.

These protection measures are expected to increase the survival of juvenile fish passing the Rock Island Dam. Studies conducted in 1999 estimated survival at 95.8 (± 2.8) percent for PIT-tagged hatchery steelhead (Stevenson et al. 2000). In 1998, studies conducted with hatchery reared yearling fall-run chinook salmon resulted in estimated survival levels of 89.3 percent (Eppard et al. 1999). However, several more years of studies are necessary to reliably assess survival rates over a variety of environmental conditions.

Adult Migration/Survival

Although the combined effects of all Columbia River hydroelectric projects on these species is unknown at this time, many of the effects are likely cumulative. The presence of these dams results in migration delay, thereby influencing migration speed and timing of adult fish. However, the increased migration speed of adults passing though the relatively slack water reservoirs might result in no appreciable change to overall migration timing of returning adult fish compared to natural river conditions. The potential effects of project operations on adult migration and survival are discussed in Section 4.2.2.1 under Adult Migration/Survival.

There is very little data available to assess the survival of adult anadromous salmonids passing the Mid-Columbia River projects. Radio-telemetry evaluations conducted between 1993 and 1998 contain the bulk of the available information, although survival was not specifically addressed in any of these studies. Although the radio-telemetry technique is problematic for addressing adult passage survival, the study results are the best available data for determining potential project related affects.

Reservoir drawdown is a remote possibility under Alternative 2 (through the FERC relicensing process). Reservoir drawdown may affect the migration rate of adult fish, and unless the dams were breached, adults would still need to pass through (modified) fishways (with the potential of also affecting migration rates). A separate EIS on drawdown effects would be prepared if drawdown were to become a potential action alternative during relicensing.

The effects of project operations on migratory bull trout are unknown, although adult bull trout have been observed using the adult fishways. Based on their presence at the project and their migratory behaviors, it is likely that some portion of the population passes through the turbines and spillways, either voluntarily or involuntarily. The dams can also present a partial migration barrier that can lead to isolated or semi-isolated populations, which are generally considered less genetically fit to withstand habitat or population disturbances. The overall extent or severity of these impacts is unknown, and further studies would be needed to evaluate the potential impacts.

Wells Dam

The protection and enhancement measures planned for adult spring-run chinook salmon and steelhead under Alternative 2 would be similar to the mitigation measures discussed previously for Alternative 1.

Specific operational procedures have been developed to minimize the effects of project operations on the passage of adult fish at the project. The NMFS will assess these project facilities and operations to determine if modifications are necessary to aid in the recovery of listed species.

There is little information to suggest that substantial injuries are occurring to adult fish passing upstream through the fishladders under normal operating conditions. Therefore, the greatest potential for injury and mortality to adult fish is believed to be associated with fallback. Although the fallback rate for spring-run chinook salmon is relatively low, there is no data to determine the effects on survival. In addition, there is no fallback data for steelhead or data for the downstream passage of steelhead kelts.

Rocky Reach Dam

For the protection and enhancement of adult spring-run chinook salmon and steelhead under Alternative 2, the Chelan County PUD would maintain and operate the adult passage facility according to the existing FERC license and interim stipulations, as modified by Section 7 consultations. Specific operational procedures have been developed to minimize the effects of project operations on the passage of adult fish at the project. The NMFS will assess these project facilities and operations to determine if modifications are necessary to aid in the recovery of listed species.

At least 80 percent of the sockeye and summer-run chinook salmon passage delay occurs in the fishway entrance pools, and it is likely that similar effects are responsible for spring-run chinook salmon and steelhead delay. However, there is only limited information that indicates these factors may be affecting overall spawning success. In addition, there is little data to assess the survival of adult salmon or steelhead kelts passing downstream (Refer to section 3.2.5 for more information.).

Rock Island Dam

For the protection and enhancement of adult spring-run chinook salmon and steelhead under Alternative 2, the Chelan County PUD would maintain and operate the adult passage facilities at the project according the existing FERC license and settlement agreement and as modified by Section 7 consultations. Specific operational procedures have been developed to minimize the effects of project operations on the passage of adult fish at the project. The effects of these actions are similar to those described for the Rocky Reach Dam (refer to section 3.2.5 for more information). The NMFS will assess these project facilities and operations to determine if modifications are necessary to aid in the recovery of listed species.

Adult Reservoir Spawning

There is no available information indicating that substantial spawning activity of adult spring-run chinook salmon or steelhead occurs in the Wells, Rocky Reach, or Rock Island reservoirs, although some steelhead spawning might occur in tailrace areas (similar to summer/fall-run chinook salmon) or at the mouths of the Wenatchee and Chelan rivers. The operation of the Wells, Rocky Reach, and Rock Island hydroelectric projects may have some effect on steelhead spawning. Potential indirect effects associated with adult passage conditions at the projects are similar to those described previously (Adult Migration/Survival).

If implemented, drawdown would increase the amount of mainstem spawning habitat, although this would likely not effect spring-run chinook salmon spawning. It is not clear how much this would benefit steelhead.

Although bull trout are occasionally observed in the project areas, they are generally believed to spawn in small headwater tributaries. Therefore, project operations are not expected to directly affect bull trout spawning beyond the migration impacts that may be occurring at the dams.

Tributary Habitat Improvements

Under Alternative 2, the PUDs would only fund habitat-related measures for adult spawning and juvenile rearing in the Mid-Columbia River tributary streams if necessary to aid in the protection and recovery of listed species (as required to fully mitigate for project effects). Measures would be similar to those discussed under Alternative 3, but would be implemented specifically to address impacts to listed anadromous salmonids.

Hatchery Production

The hatchery programs currently funded by the Chelan and Douglas County PUDs were developed to mitigate for the loss of spawning habitat with the inundation of the mainstem Columbia River by the project reservoirs, and for estimated losses associated with fish passage at the projects. Under Alternative 2, these facilities would likely continue to be funded by the PUDs and operated by the WDFW or the Colville Tribe in accordance with policies and guidelines of the State and Section 10 permits issued under the provisions of the Endangered Species Act. The Section 10 permits describe the efforts implemented to avoid and minimize impacts to Endangered Species Act-listed species. These efforts include protocols for adult collection and spawning, rearing and release strategies, fish health management programs and environmental monitoring. These protocols are expected to be followed for all hatchery stocks and would equally benefit non-listed fish species. However, if NMFS determines that the current hatchery production levels are likely to jeopardize the continued existence or recovery of the listed species, the production levels could be reduced.

In an effort to ensure that hatchery practices are consistent with the recovery of listed species, the nature of the hatchery program would shift from its current production level concept to one that would include a greater emphasis on the development of locally adapted stocks.

Wells Dam

Under Alternative 2, the Douglas County PUD would continue to fund the current hatchery compensation programs for spring-run chinook salmon at the Methow Fish Hatchery, for steelhead at the Wells Hatchery, and off-site acclimation facilities according to stipulations in the 1990 Wells Settlement Agreement (FERC 1991). Operation of the Wells Hatchery has been reviewed under Section 7 and a Section 10 permit #1094 was issued to WDFW on February 4, 1998. Operation of the Methow Fish Hatchery is currently being considered in the review of Section 10 permit #1196 (to WDFW) and a biological opinion is in preparation concerning NMFS' issuance of that permit. Therefore, there are no additional impacts on spring-run chinook salmon and steelhead associated with the Wells hatchery compensation program expected under Alternative 2.

The Methow and Wells hatcheries were established as part of the 1990 Wells Settlement Agreement and were intended to compensate for an assumed total project mortality rate of 14 percent (including reservoir and dam passage). However, recent juvenile survival studies suggest that the current hatchery compensation level is greater than the apparent fish losses resulting from dam passage. Under Alternative 2, the compensation levels could be adjusted to reflect the actual fish passage losses, according to stipulations in the 1990 Wells Settlement Agreement.

Since inception in 1992, the Methow Hatchery has been operated under a supplementation strategy. Under this program, the genetic integrity of the Methow River chinook salmon stock supercedes the hatchery production goals established in the 1990 Wells Settlement Agreement. As a result, current management objectives and hatchery operation criteria have reduced the production levels by about 25 percent compared to the goals established in the settlement agreement (Douglas County PUD 1999a). The hatchery program also includes the development of spring-run chinook salmon broodstock management protocols and the volitional release of smolts from acclimation ponds located in tributaries. These measures may lead to improved return per spawner ratios, benefiting listed species.

Rocky Reach Dam

The Turtle Rock and Chelan Falls hatcheries are owned by the Chelan County PUD and operated by the WDFW. They have previously been reviewed under Section 7 and issued a Section 10 permit (#1094 to WDFW). The Section 10 permit describes efforts made by the agency to avoid and minimize impacts to listed species (similar to those describe previously). Therefore, there are no additional impacts to spring-run chinook salmon and steelhead associated with the hatchery compensation program expected under Alternative 2.

Under Alternative 2, the Chelan County PUD would continue to fund the operation and maintenance of these hatcheries at a level equivalent to the 1996 budgeted operation and maintenance costs, adjusted annually for inflation. The existing production capacities are believed to compensate for juvenile fish passage losses and for original inundation behind Rocky Reach Dam. The hatchery program would likely continue to be operated by WDFW, in a manner consistent with the recovery of spring-run chinook salmon and steelhead populations. As a result, the Chelan County PUD is currently working with the fishery agencies and Tribes to develop a conservation/supplementation strategy instead of a strictly numerical compensation program used in the past. Under Alternative 2, NMFS would require that these programs use locally adapted broodstock to the extent possible.

Rock Island Dam

The East Bank and Chiwawa hatcheries are owned by the Chelan County PUD and operated by the WDFW. The spring-run chinook salmon programs are currently being considered in the review of Section 10 permit #1196 (to WDFW) and a biological opinion concerning NMFS' issuance of that permit is in preparation. The Section 10 permit requirements are similar to those described previously. Therefore, there are no additional impacts on spring-run chinook salmon and steelhead associated with the hatchery compensation program expected under Alternative 2.

The Chelan County PUD would continue to fund the operation and maintenance of these hatcheries at a level equivalent to the 1998 budgeted operation and maintenance costs, adjusted annually for inflation. The existing production capacities are believed to compensate for juvenile fish passage losses and for original inundation behind Rock Island Dam. The hatchery operation protocols are similar to those described previously for Rocky Reach Dam.

Associated Tributaries

Potential impacts associated with hatchery supplementation in the Mid-Columbia River tributaries are similar to those described under Alternative 1, and include the potential interactions between hatchery and wild stocks (competition, predation, and disease transmission), and the potential changes or alterations to the genetic integrity and diversity of both populations. However, modifications likely to occur under Alternative 2 would lead to improved return per spawner ratios, benefiting listed species.

Monitoring and Evaluation

The level of uncertainty surrounding the available survival information for juvenile and adult salmonids passing the Mid-Columbia River hydroelectric projects cannot be overstated. Although considerable research activities have been conducted since the construction of these projects, the compounding influences of other activities in the basin, as well as modifications to the projects, and research data uncertainties have often produced inconclusive results. Therefore, it is of utmost importance to implement or continue the monitoring programs that focus on project specific direct and indirect impacts, as well as system-wide cumulative impacts.

Under Alternative 2, the PUDs would continue to implement research and monitoring as necessary to ensure that mitigation measures implemented at each of the projects are achieving the goals outlined in the existing license articles, settlement agreements, and interim stipulations. Additional research would also be required to determine the survival of both juvenile and adult spring-run chinook salmon and steelhead at the projects and through the system. In addition, evaluations to determine what effects adult passage conditions have on adult spawning success and fecundity would be required, as would evaluations to determine the extent of kelt passage and the contribution of kelts to the overall population structure of listed steelhead. Extensive water quality monitoring would be required, as would evaluations of methodologies to reduce total dissolved gasses. Life cycle modeling evaluations would also be conducted periodically to ensure that the species are recovering. This information is vital to the development and monitoring of long-term protection measures.

Wells Dam

Under Alternative 2, the Douglas County PUD would conduct the monitoring and evaluation measures required under Alternative 1, in addition to implementing several other monitoring and evaluation activities to ensure that project and system survival of both juvenile and adult spring-run chinook salmon and steelhead has been maximized as needed to ensure the recovery of listed species. Increased water quality monitoring might also be required to ensure that the project was operating with as little impact as possible on a real-time basis.

Although the effectiveness of the existing mitigation measures for juvenile fish appears to be high (total project survival estimated near 97 percent for all anadromous species), survival estimates over varying river flow conditions and year classes are needed to determine if these programs are adequate to promote the recovery of listed species over the long-term. Uncertainties regarding adult survival estimates based on radio-telemetry indicate that new survival assessment techniques need to be developed for this life stage. Therefore, the Douglas County PUD would assist in developing and implementing these evaluations as well. The Douglas County PUD would also be required to participate in periodic run status modeling efforts to ensure that the species are recovering.

Rocky Reach Dam

Under Alternative 2, the Chelan County PUD would continue to conduct monitoring and evaluation measures similar to those described under Alternative 1, in addition to efforts similar to those described for the Wells Dam under Alternative 2.

Rock Island Dam

Under Alternative 2, the Chelan County PUD would continue to conduct monitoring and evaluation measures similar to those described under Alternative 1, in addition to efforts similar to those described for the Wells Dam under Alternative 2.

Columbia River System

A discussion of the cumulative effects associated with the operation of the Mid-Columbia River hydroelectric projects on the Endangered Species Act-listed fish species is provided in Section 4.1 and is based on the QAR analyses. These analyses suggest that any potential changes to the Mid-Columbia River projects under Alternative 2 (including dam removal) would not meet the extinction and recovery criteria unless accompanied by improvements in the overall life-history survival conditions. The QAR analyses do indicate however, that the extinction risks substantially decrease as survival through the hydrosystem is improved.

4.2.3.2 Other Anadromous Species

Similar to Alternative 1, the criteria for protecting non-listed species under Alternative 2 are based primarily on project operational guidelines outlined in the existing FERC licenses, settlement agreements, and interim stipulations rather than survival criteria. Thus, Alternative 2 would not necessarily provide the same level of protection to non-listed salmonid species as it provides for the listed species. Despite this potential difference, the species discussed in this section are generally expected to benefit from the protection procedures instituted for the listed species due to the overlap in both migration timing and habitat utilization.

Drawdown would have similar effects on the non-listed species, as described previously for the

Endangered Species Act-listed species. However, summer/fall-run chinook salmon are primarily mainstem spawning fish so the increased spawning habitat resulting from reservoir drawdown is expected to benefit them to a greater degree.

Juvenile Migration/Survival

Wells Dam

There would be no additional measures implemented at the Wells Dam under Alternative 2 for non-listed species, beyond what is currently required under the existing FERC license and settlement agreement. However, non-listed species are expected to benefit from some of the measures implemented for listed species, especially for those species that have similar run timing and/or utilize common habitat. For example, juvenile protection measures that may be required for spring-run chinook salmon and steelhead would likely benefit sockeye and coho salmon as well. In addition, modifications made to tributary habitat are expected to benefit all species distributed in the area.

Currently, the Wells bypass system has an average fish passage efficiency of 92 percent for all spring migrants, and 96 percent for all summer migrants (Skalski 1993) and the overall survival rates for the non-listed anadromous species are expected to be similar to those discussed for the listed species.

Rocky Reach Dam

There would be no additional measures implemented at the Rocky Reach Dam under Alternative 2 for non-listed species, beyond what is currently required under the existing FERC license and interim stipulation. However, non-listed species are expected to benefit from some of the measures implemented for listed species, especially for those species that have similar run timing and/or utilize common habitat. These potential benefits are similar to those listed above for the Wells Dam.

The main goal of the juvenile fish mitigation measures at the Rocky Reach Dam for non-listed species is to develop a safe (less than 2 percent mortality) bypass system capable of passing 80 percent of the juvenile migrating salmon and steelhead over 90 percent of the migration period. Although the protection measures are not based on survival rates, survival can be estimated to allow comparisons between the EIS alternatives. Based on available information, estimates of juvenile survival for the non-listed anadromous salmonid species ranges from 92.5 percent for sockeye salmon to 95.1 percent for summer-run chinook salmon (see Table 3-3). Although these survival rates are below the 95 percent goal established for Endangered Species Act-listed species in the HCP (Alternative 3), they may be adequate for protecting populations that are not as depressed.

Although increased survival rates of non-listed species would likely occur as an indirect result of improvements made at the project to reach the survival goals of the listed species, some plan protection measures that might be beneficial to the listed species might actually be detrimental to others. For example, turbine intake screens would likely improve the survival rate of spring-run chinook salmon and steelhead but present a significant impingement and descaling hazard to sockeye and subyearling fall-run chinook salmon.

Additional protection measures for non-listed species might also be provided during the relicensing process currently underway for Rocky Reach Dam.

Rock Island Dam

There would be no additional measures implemented at the Rock Island Dam under Alternative 2 for non-listed species, beyond what is currently required under the existing FERC license and settlement agreement. However, similar to the Wells and Rocky Reach dams, non-listed species are expected to benefit from some of the measures implemented for listed species.

Because the primary method for maximizing juvenile anadromous fish survival at the Rock Island Dam is through spill, the additional spill required for listed species could potentially result in less protection for juvenile fall-run chinook salmon due to the limitations of the Conservation Account. It would be NMFS' intent to maintain the Conservation Account for summer-run chinook salmon although specific negotiations with the PUD, FERC and the resource agencies would be required to resolve this issue. Although there is no Endangered Species Act requirement to provide spill for juvenile fall-run chinook salmon, FERC and the PUD have an obligation to mitigate for the effects of project operations on these species as well.

Similar to the juvenile fish mitigation measures for non-listed species described for Rocky Reach Dam, the protection programs at Rock Island Dam are prescriptive, and do not include survival goals. For the purposes of comparing alternatives, however, expected survival under Alternative 2 can be estimated using the best available data (and assuming that spill would be implemented at least to the same level that has been implemented under the existing Conservation Account).

Based on available information, juvenile survival for the non-listed anadromous salmonid species passing the Rock Island Dam are expected to range from 92.6 percent for sockeye salmon to 93.9 percent for fall-run chinook salmon (see Table 3-3).

Adult Migration/Survival

Results from several radio-tag studies have indicated that the adult fishways at the Mid-Columbia River dams are generally effective at providing passage for anadromous adult fish, although passage times for summer- and fall-run chinook salmon appear to be longer than for spring-run chinook salmon and steelhead (see Table 2-4). Summer- and fall-run chinook salmon are also likely to be more vulnerable to delays because their migrations extend longer into the summer when water temperatures are higher. Higher temperatures increase metabolic rate and result in greater energy expenditures by migrating fish. Their migration period also tends to be closer to their spawning periods, allowing less time to compensate for migration delays. Although these factors might be increasing the rate of pre-spawning mortality for some of the anadromous species, there is no data to verify or quantify the impacts.

Under Alternative 2, the adult fishways at the PUD projects would be operated according to the same criteria as described under Alternative 1. Potential improvements identified as a result of evaluations conducted for listed species are also expected to benefit the non-listed species. Reductions in adult mortality and fallback, as well as the protection of downstream migrating steelhead kelts (post-spawning adults), would be factored into the juvenile bypass systems, adult passage development, and implementation processes and into project operation protocols.

Wells Dam

Radio-telemetry evaluations at the Wells Dam indicate that summer- and fall-run chinook salmon experienced passage delays negotiating the collection channel and entering the ladder (see Table 2-4). However, recent modifications to ladder operations have indicated a substantial reduction in the passage times of adult summer- and fall-run chinook salmon. Closing the side entrances to the ladder resulted in passage time reductions from 52.5 to 20.6 hours in 1997 and from 38.5 to 19.0 hours in 1998. Additional studies will be conducted in 2001 to verify the effects of closing the side entrances. There is no indication that sockeye salmon experience substantial delays passing the project. Although there are no known direct sources of mortality to adult salmonids at Wells Dam under normal operating conditions, mortality could occur as a result of fallback. However, the magnitude of the effects is unknown.

Under Alternative 2, the Douglas County PUD would maintain and operate adult passage facilities in accordance with the 1990 Settlement Agreement (FERC 1991). The Douglas County PUD would also continue to operate spill and turbine units in a manner that optimizes adult passage, while meeting requirements for juvenile fish passage. The implementation of these plans is expected to minimize the impacts to adult fish passing the project.

Rocky Reach Dam

Under Alternative 2, the Chelan County PUD would maintain and operate adult passage facilities in accordance with the existing FERC license and interim stipulation. As with the fishways at the Wells Dam, there is evidence to suggest that sockeye and summer-run chinook salmon experience passage delays in the fishway entrance pools at Rocky Reach Dam. However, there is no data to suggest any direct injury or mortality resulting from fish passage under normal operating conditions.

Rock Island Dam

Under Alternative 2, the Chelan County PUD would maintain and operate adult passage facilities in accordance with the existing FERC license and settlement agreement. The potential problems associated with passage through these fishways are attributed to delays in locating the entrances, and in the junction pools. However, the available data suggest that passage conditions at Rock Island are better than at Rocky Reach or Wells dams (see Table 2-4).

Adult Reservoir Spawning

No direct effects of project operations on sockeye salmon spawning are expected because they spawn well upstream of the projects in streams associated with Lake Wenatchee and Lake Osoyoos. Summer/fall-run chinook salmon is the one species that is expected to exhibit substantial spawning activity in the Mid-Columbia River reservoirs. However, the spawning habitat is primarily restricted to upper reservoir or tailrace areas (see Section 4.2.2.2).

Hatchery Production

As discussed previously, the hatcheries funded by the Chelan and Douglas County PUDs are operated by the WDFW and Colville Tribe in accordance with policies and guidelines of the State and Section 10 permits issued under the provisions of the Endangered Species Act. Hatchery operations for non-listed species, under Alternative 2, are expected to be similar to those described for Alternative 1 (see Section 4.2.2.1).

Tributary Habitat Improvements and Monitoring

The previous discussions of tributary habitat improvements and monitoring programs, related to the Endangered Species Act-listed stocks, are also expected to be applicable to the non-listed species under Alternative 2 (see Section 4.2.2.1).

4.2.3.3 Resident Fish Species

Project Areas

The potential effects of project operations on resident fish, under Alternative 2, are the same as those discussed previously for Alternative 1 (see Section 4.2.2.3).

Associated Tributaries

Project operations under Alternative 2 would not alter tributary habitat or resident fish populations that occur there. However, migratory species that move between the tributary and reservoir areas might be affected by project operations, as discussed previously. These affects are not expected to be substantially different from existing conditions.

Columbia River System

With the possible exception of increased total dissolved gas levels resulting from spill at the projects, project operations have little effects on resident populations in the lower Columbia River. However, improved fish bypass facilities for the listed species under Alternative 2 might result in a reduction in the amount of spill required at the projects to provide adequate fish passage efficiency (particularly at Rock Island and Rocky Reach dams).

4.2.4 ALTERNATIVE 3

The HCPs represent long-term protection, mitigation, and enhancement plans for all Plan species, as well as recovery plans for Endangered Species Act-listed species. The HCPs include provisions to minimize the direct effects of project operations on fish species and aquatic resources, as well as provisions for hatchery funding and tributary habitat restoration activities. These latter features are intended to compensate for unavoidable impacts that cannot be mitigated or eliminated as part of project operations or improvements made to project structures.

The HCPs are intended to be consistent with an evolving basin-wide effort to protect salmonids that originate upstream of the Mid-Columbia River hydroelectric projects. The focus of the HCPs is to establish a cooperative planning and implementation process to achieve specific survival standards for all anadromous salmonid species, regardless of their Endangered Species Act listing status. This effort would include the participation of State and Federal fishery agencies and local Native American Tribes.

4.2.4.1 Threatened and Endangered Species

The survival standards established in the HCPs were initially developed through negotiations between State and Federal resource agency, PUD, and Tribal biologists. The QAR was then developed with the support and participation of each of these groups, and established that, by implementing the HCP standards (at all five Mid-Columbia River PUD projects), juvenile survival would increase to between 116 and 135 percent of the recent survival levels (1982-1996 juvenile passage years). In addition, implementation of the proposed Tributary Conservation Plan would further increase survival to between 123 and 149 percent of the recent survival levels. However, despite these survival gains, similar survival improvements would also be necessary for the four Federal projects on the lower Columbia River to reduce the overall risks of extinction to below established criteria.

Under Alternative 3, the PUDs (in consultation with the applicable coordinating committees) could use a variety of protective measures to reach the survival standards. These measures could be used independently or in any combination to achieve the performance standards for all Plan species, including the listed spring-run chinook salmon and steelhead. In comparison, the protective measures implemented under Alternative 2 would be implemented to maximize the survival of listed species, while the protection for non-listed species would be provided by the existing FERC licenses, settlement agreements, and interim stipulations.

As discussed, bull trout are not included as a Plan species. Therefore, the survival standards established in the HCPs do not apply. The FERC has initiated informal consultations with the USFWS under Section 7 of the Endangered Species Act to begin evaluating the effects of project operations on bull trout.

Juvenile Migration/Survival

Wells Dam

Programs for the protection of Plan species juveniles under Alternative 3 would be based on achieving no net impact. The juvenile fish passage component of the no net impact standard is to achieve 95 percent juvenile passage survival through the dam. Total project survival estimates are 99.7 percent for hatchery reared juvenile spring-run chinook salmon (Bickford et al. 1999), and 94.3 percent for hatchery reared steelhead smolts (Bickford et al. 2000) under the existing conditions. If the success of the Wells bypass is equally beneficial for all Plan species, there would be no additional requirements over the next 50 years to increase dam passage survival unless survival fell below 95 percent in the future.

The predator control programs would continue to be implemented and are expected to benefit all Plan species, bull trout and other resident species. The continuation of juvenile survival studies, using the latest improvements in fish tagging technology, would result in substantially better estimates of actual survival rates over a variety of river and project operational conditions. These results would be used to modify dam passage structures and operations if the standards were not being met.

Adjustments to the compensation levels, as a result of the survival studies, would occur under Phase III of the HCP. If survival studies show that the dam passage survival standards are being met, current hatchery compensation programs for the Wells project would be reduced. The Douglas County PUD could either reduce the existing 14 percent compensation level to 7 percent or could allow other Mid-Columbia PUDs to fund the production capacity of the Methow or Cassimer Bar hatcheries for their own mitigation programs. The existing production levels at the Wells Hatchery that provides compensation for original habitat inundation would continue at current levels. However, part of the 420,000 steelhead produced at the Wells Hatchery as compensation for assumed unavoidable juvenile dam passage losses could be reduced under Phase III of the HCP agreement. Under Alternative 3, hatchery supplementation cannot increase beyond 7 percent.

The Douglas County PUD contribution to the Plan Species Account, which is the mechanism for funding the habitat improvement projects, would be adjusted (if appropriate) at 5-year intervals during the 50-year term of the HCP. This provision provides opportunities to compensate for the exact level of unavoidable project passage losses based on assessments of adult returns and through the 2 percent credit for the Tributary Fund. Current information suggests that the actual mortality rates of fish passing the project is substantially less than the existing 14 percent compensation rate set in the 1990 Wells Settlement Agreement for the Methow and Cassimer Bar hatcheries. Therefore, it is possible for the Wells funding levels for these hatcheries to decrease under all the Alternatives (1, 2, and 3).

Rocky Reach Dam

Programs for the protection and enhancement of spring-run chinook salmon and steelhead, under Alternative 3, would be based on the same performance standards as those described for the Wells Dam. Although project operations under Alternative 3 would be similar to those outlined for Alternative 2, the effectiveness of these operations would be evaluated and modified, with the requirement of making continual progress toward achieving no net impact.

If the information obtained from the recent PIT-tag evaluation of hatchery reared steelhead smolts (95.9 percent reservoir and dam passage survival) holds true for all Plan species under varying environmental conditions over successive outmigrations, no additional measures would be required (Section 4.2.2.1 under Juvenile Migration/Survival). In contrast, if survival rates were not met, as indicated by the 1998 yearling fall-run chinook salmon study, additional protection measures would be implemented. For Alternative 3, the PUD would have the ultimate authority for determining the appropriate protection measures implemented during Phase I, while the Coordinating Committee would have a greater role during Phase II. Under Alternative 2, NMFS would have the primary responsibility for determining the appropriate measures for listed species, although extensive coordination with the Mid-Columbia Coordinating Committee would likely occur.

Improving juvenile dam passage survival might be accomplished through additional modifications to the bypass system. However, increasing the proportion of fish passing through the surface collection system would be increasingly more difficult due to the limited number of fish that are available for passage at this location. This limitation is due to the configuration of the dam that creates a cul-de-sac on the powerhouse side of the forebay. Fish migrating down the other side of the river would not enter the area influenced by the attraction flow of the collector until they had avoided passing the project through the spillway and most of the turbine units. In addition, increasing the efficiency of one aspect of the collector may result in a decrease in the efficiency of another due to the finite number of fish in the cul-de-sac.

Installing additional turbine intake screens at Rocky Reach Dam is also problematic because of the potential injury and impingement rates to other species, such as sockeye salmon, subyearling chinook salmon, and lamprey. In addition, the number of fish that pass through the higher numbered turbines (currently unscreened) is substantially lower than the units that currently have screens.

Because of the potential limitations related to increasing fish passage through the surface bypass system, spill might continue to be a component of the juvenile passage system at the Rocky Reach Dam during the HCP term. However, the use of spill may be limited by water quality standards for total dissolved gas (Section 3.3). This might require the implementation of a total dissolved gas abatement program, such as spillway flow deflectors.

Although there is considerable difficulty measuring the effectiveness of habitat improvement projects, there are numerous areas with degraded habitat in the Mid-Columbia River tributaries that would benefit from improvement or plan protection programs. Improved tributary habitat conditions are expected to benefit all naturally spawning Plan species.

Rock Island Dam

Performance standards for juvenile fish passage at the Rock Island Dam are the same as those described for the Wells and Rocky Reach dams. Although project operations under Alternative 3 would be similar to those for the listed species under Alternative 2, the effectiveness of these operations would be evaluated and modified, with the goal of making continual progress toward achieving no net impact to all the Plan species.

If the information obtained from the recent PIT-tag evaluation with hatchery steelhead smolts (95.8 percent reservoir and dam passage survival) holds true for all Plan species under varying environmental conditions over successive outmigrations, no additional measures would be required (Section 4.2.2.1 under Juvenile Migration/Survival). In contrast, if the survival estimated for yearling fall-run chinook salmon (89.3 percent) (Eppard et al. 1999) is accurate, additional plan protection measures would be implemented under Alternative 3. Under the HCP, the PUD would have the ultimate responsibility for determining the appropriate protection measures implemented during Phase I, while the Coordinating Committee would have an increased role during Phase II. Under Alternative 2, NMFS would have a stronger role in determining the appropriate measures for listed species, although significant coordination with the Rock Island Coordinating Committee would occur.

Spillway fish passage is expected to be the primary method of increasing juvenile fish survival at the project. Although the use of turbine intake screens is a potentially viable measure for implementation at Powerhouse 1, the potential impingement and injury rates to some of the other Plan species, and to other resident species and lamprey, may minimize their use under Alternative 3.

The assumed reliance on spillway passage to achieve the juvenile dam passage survival standards might be limited by the generation of high total dissolved gas levels in downstream areas as a result of spilling water at the project. However, the possible addition of spillway flow deflectors would likely minimize total dissolved gas production.

Adult Migration/Survival

The protection measures planned for improving adult migration and survival for spring-run chinook salmon and steelhead under Alternative 3 are similar to those discussed under Alternative 2 (Section 4.2.2.1 under Adult Migration/Survival).

In addition to the protocols listed under Alternative 2, the PUDs would emphasize adult project passage measures to ensure achievement of the 91 percent project survival rate for each Plan species. The PUDs would also modify areas of the adult fish passage system that are identified as consistently out of criteria or where significant delay occurs, as well as using best efforts to eliminate identified sources of adult injury or mortality. Although the inclusion of the no net impact standard in the HCP under Alternative 3 incorporates adult survival into the overall 91 percent project survival standards, there are no specific plans to assess overall adult survival at the projects under Alternative 3 until accurate assessment procedures are available. Although radio-telemetry methodologies are the best procedures to assess adult passage conditions at hydroelectric projects, they have proven to be problematic for assessing survival.

The effects of water temperature, passage delays and fallback can indirectly affect spawning success. Adult spring-run chinook salmon and steelhead do not feed during their upstream migration, so they must expend considerable energy reserves for migrating and sexual development. Therefore, migration delays resulting from project passage can result in additional energy expenditures that might result in increased pre-spawning mortality or reduced spawning success. Although the effects of a single project are likely not substantial, the cumulative effects of multiple projects could have a measurable impact. As discussed earlier, however, adult spring-run chinook salmon and steelhead enter the Mid-Columbia River several months before spawning, which reduces the potential effects of passage delays on spawning success.

Adult Reservoir Spawning

There is no available information indicating that substantial spawning activity of adult spring-run chinook salmon or steelhead occurs in the Wells, Rocky Reach, or Rock Island reservoirs, although some steelhead spawning might occur in tailrace areas (similar to summer/fall-run chinook salmon) or at the mouths of the Wenatchee and Chelan rivers. The operation of the Wells, Rocky Reach, and Rock Island hydroelectric projects may have some effect on steelhead spawning. Potential indirect effects associated with adult passage conditions at the projects are similar to those described previously in this section (under Adult Migration/Survival).

If implemented, drawdown would increase the amount of mainstem spawning habitat, although this would likely not affect spring-run chinook salmon spawning. It is not clear how much this would benefit steelhead.

Although bull trout are occasionally observed in the project areas, they are generally believed to spawn in small headwater tributaries. Therefore, project operations are not expected to directly affect bull trout spawning beyond the migration impacts that may be occurring at the dams.

Off-Site Mitigation

The primary means to achieve no net impact to the Plan species is to increase the survival of fish passing the projects. However, for the 9 percent unavoidable project related mortality, compensation would be accomplished through hatchery production and tributary habitat protection and restoration projects.

Under Alternative 3, the PUDs would provide funding and hatchery production capacity to meet 7 percent of the compensation level necessary to achieve no net impact. The initial hatchery production level is based on average adult returns of the Plan species for a baseline period, a 7 percent compensation requirement, and baseline adult/smolt survival rates. This estimated initial production capacity would be adjusted periodically to account for changes in the adult run size. Compensation levels established to mitigate for initial inundation by the projects would not be adjusted.

The PUDs would also contribute funding to the Plan Species Account to pay for tributary habitat protection and restoration projects in the basin. This funding would provide compensation for an additional 2 percent of the unavoidable project mortality, to meet the no net impact standard. The contribution levels to the Plan Species Account are established in the HCPs and anadromous fish agreements and would remain fixed for the 50-year term of the HCPs. It is assumed that the funding planned (as described in Section 2.3.3.12) is adequate and representative of a 2 percent compensation level.

Hatchery Production

No specific facility changes are proposed for hatchery production under Alternative 3. The operation of the hatchery facilities being funded by the PUDs have either been previously addressed or would be addressed in separate biological opinions and corresponding Section 10 permits. Hatchery production is based on initial inundation of fish habitat and ongoing fish losses from hydroelectric project operation. Under the existing FERC licenses and settlement agreements, assumptions were made concerning ongoing fish losses at the projects. If the HCPs were implemented, supplementation levels would be 7 percent.

Although supplementation at the Wells Dam would be reduced from the current level of 14 percent to 7 percent, the current programs at the Rocky Reach and Rock Island dams are considered to represent the 7 percent commitment. The hatchery facilities that were developed to compensate for ongoing fish passage losses at the Mid-Columbia River projects are the Methow, Wells, and Cassimer Bar hatcheries for the Wells Dam, the Eastbank Hatchery for the Rock Island Dam, and the Chelan Hatchery for the Rocky Reach Dam. Therefore, the production levels at these facilities might change as a result of implementing the HCPs.

Although no specific modifications to the hatcheries were identified in the HCPs, there is the potential that operations of the hatcheries could be altered. These potential alterations are likely to be the result of requirements under the independent Section 10 permits (see Alternative 2). However, there are no substantial differences between the hatchery programs under Alternatives 2 and 3.

Tributary Habitat Improvements

The tributary habitat improvement projects conducted under Alternative 3 would be funded through a Plan Species Account. The initial PUD contributions to the fund would be based on compensation to mitigate for 2 percent of unavoidable fish passage mortality. Combined with the overall survival rate goal of 91 percent and the 7 percent hatchery compensation rate, the total compensation would result in no net impact to all Plan species.

The funds provided by the PUDs to the Plan Species Account would supplement funding from other conservation plans or programs to preserve and enhance fish habitat and water quality within the region. Whenever feasible, the Tributary Committee would coordinate with other programs to establish a cost-sharing process, seek matching funds, and piggyback programs onto other habitat improvement efforts.

Tributary habitat improvement measures would be selected based on biological soundness and cost efficiency, and ultimately decided upon by the Tributary Committee. The selection criteria include concepts for providing increased spawning and rearing habitat for critical populations not adequately mitigated by other measures, or improving survival rates during critical life stages or time periods. Because the HCPs are multi-species plans, the biological requirements of all the Plan species would be included in the decision-making process. Therefore, the tributary improvement activities are expected to be beneficial to all Plan species.

Tributary habitat conservation and restoration efforts conducted under Alternative 3 would place the highest priority on maintaining and improving stream channel diversity and floodplain function. The principal means of meeting this objective is to conserve and protect riparian habitat. Such measures are expected to result in an overall improvement in incubation and rearing conditions for all fish species that occur in the tributary streams. The protection and enhancement of riparian habitat is expected to decrease bank erosion, sedimentation and/or scouring of channel substrate, and improve water quality in the tributary stream areas. These efforts are expected to result in increased natural production levels for both anadromous and resident fish species.

Habitat conservation and restoration measures that would increase the natural production of anadromous fish species (as well as for bull trout) would include, but not be limited to:

- providing access to currently blocked stream sections or oxbows,
- removing dams or other passage barriers on tributary streams,
- improving or increasing the hiding and resting cover habitat that is essential for these species during their relatively long holding period, and
- improving in-stream flow conditions by correcting problematic water diversion or withdrawal structures.

Such tributary habitat conservation and restoration measures are expected to improve the migration conditions for all anadromous or migratory fish species and increase the opportunities for successful spawning. Considering the current habitat conditions in the tributary streams, habitat improvement projects are expected to have a net benefit to most fish species, and other aquatic organisms.

Monitoring and Evaluation

Monitoring efforts for all Plan species under Alternative 3 are similar to those for threatened and endangered species under Alternative 2. However, there are no specific research and monitoring requirements under Alternative 3 beyond ensuring that the standards have been met. As an example, there are no water quality monitoring efforts required under the HCPs (i.e., total dissolved gas, temperature, gas bubble disease monitoring, etc.) nor are there specific requirements to evaluate juvenile fish passage efficiency, run timing, or adult passage rates. The WDOE may however, require water quality monitoring in addition to the requirements under the HCPs. Additional monitoring could also be required as a result of project relicensing procedures.

Columbia River System

A discussion of the cumulative effects associated with the operation of the Mid-Columbia River hydroelectric projects on the Endangered Species Act-listed fish species is provided in Section 4.1 and is based on the QAR analyses. These analyses suggest that any potential changes to the Mid-Columbia River projects under Alternative 3 (including dam removal) would not meet the extinction and recovery criteria unless accompanied by improvements in the overall life-history survival conditions. The QAR analyses do indicate however, that the extinction risks substantially decrease as survival through the hydrosystem is improved through the implementation of the HCPs.

4.2.4.2 Other Plan Species

Summer/fall-run chinook and sockeye salmon also occur in the Mid-Columbia River area and are included as Plan species in the HCPs. Mid-Columbia River coho salmon are considered extinct, and would therefore not be protected under the Endangered Species Act statutes but are included as an HCP Plan species. There are some residual coho salmon populations in the Mid-Columbia River as a result of prior hatchery programs, and evaluations are being conducted to assess the feasibility of a coho salmon reintroduction program.

These three Plan species are expected to benefit from improvements in juvenile and adult fish passage facilities developed for the threatened and endangered species under both action alternatives, as well as tributary habitat improvement programs implemented under Alternative 3. This alternative also applies the same survival rate performance standards for these Plan species as for the threatened and endangered species discussed previously.

Juvenile Migration/Survival

There are limited data concerning specific project effects on passage survival for each individual anadromous fish species. Although data collected on one anadromous fish species is used as a general surrogate for the other species, survival assessments for each Plan species are required to satisfy the HCP requirements.

The juvenile fish passage survival standards and proposed plan protection programs for the other Plan species are the same as those described for the threatened and endangered species under Alternative 3 (Section 4.2.4.1). Additional information specific to the other Plan species is also discussed under Alternative 2 (Sections 4.2.3.1 and 4.2.3.2).

Wells Dam

Based on fish passage efficiency information, the survival rates of the other Plan species are expected to be comparable to those for spring-run chinook salmon and steelhead. As a result, significant modifications to the juvenile bypass system are not expected to occur. However, research and monitoring will be required for each Plan species to determine if the HCP survival standards are being met. Failing to meet these performance standards would require the use of additional tools or the implementation of a dispute resolution process. Detailed discussions of the potential long-term implications of implementing the provisions of the HCP are provided previously in Section 4.2.4.1 under Juvenile Migration/Survival.

Rocky Reach Dam

Although project operations under Alternative 3 might be similar to those for Alternative 2, the effectiveness of these operations would be evaluated and modified, with the goal of making continual progress toward achieving no net impact.

Survival estimates are limited for the other Plan species. The reservoir and dam passage survival studies conducted in 1998 and 1999 (Eppard et al. 1998; Bickford et al. 1999) estimated the combined passage survival for yearling fall-run chinook salmon at between 83.5 and 93.9 percent; however, naturally produced fall-run chinook salmon outmigrate as subyearlings during the summer (as opposed to the hatchery reared fall-run chinook salmon that outmigrate as yearlings during the spring). Additional estimates, based on the proportion of fish that use the various passage routes and the assumed survival for each route, suggest that the survival of these species passing Rocky Reach Dam is currently less than the 95 percent HCP survival standard. Thus, additional plan protection measures might be required to meet the HCP performance standards for all the Plan species.

Protection measures planned to improve juvenile fish passage survival at the project are similar to those discussed previously for threatened and endangered species (Section 4.2.2.1 under Juvenile Migration/Survival). However, the inclusion of these other Plan species under the no net impact provisions of the HCP might eliminate or limit the use of certain fish passage enhancement measures at the project. For example, sockeye salmon and early summer/fall-run chinook salmon migrants are believed to be more susceptible to injury and descaling from turbine intake screens. This might prevent the use of additional intake screens to improve the surface collector bypass efficiency. Minimizing the use of intake screens might also benefit other fish species that are not specifically included as Plan species (e.g., Pacific lamprey).

As discussed, the inability to meet the specified survival performance standards for any of the Plan species by 2003 would require additional protection measures. The protection measures would be on-site structural or operational modifications. Failing to meet these performance standards would require the use of additional tools or the implementation of a dispute resolution process.

Rock Island Dam

For the protection of these Plan species under Alternative 3, the Chelan County PUD would continue to operate Rock Island Dam in accordance with the settlement agreements and protection plans discussed previously for threatened and endangered species (Section 4.2.2.1 under Juvenile Migration/Survival). As previously discussed, the primary measures for maximizing juvenile fish passage survival at the Rock Island Dam is through improved spill and increased predator control programs.

Although survival measurements are limited for these Plan species, Eppard et al. (1998) estimated the combined reservoir and dam passage survival for hatchery reared yearling fall-run chinook salmon at 89.3 percent; however, naturally produced fall-run chinook outmigrate as subyearlings during the summer (as opposed to the hatchery reared fall-run chinook that outmigrate as yearlings during the spring). In addition, calculating individual survival rates for the various passage routes (using measured or assumed survival and passage rates for each passage route) suggest that the dam passage survival rate might be below the HCP performance standards. If this is verified through project specific survival studies, additional measures might be needed to meet the survival standards.

These measures might include:

- modifying additional spill gates,
- developing a powerhouse surface collector and bypass system,
- installing a forebay guidance curtain,
- installing turbine intake screens at Powerhouse 1, or
- modifying the turbines to increase turbine passage survival.

These plan protection measures, used individually or in combination are expected to improve the survival of juvenile salmon and steelhead smolts passing the project to levels approaching the survival standards of the HCP. Failing to meet these performance standards would require the use of additional tools or the implementation of the dispute resolution process.

Adult Migration/Survival

The procedures and measures for improving adult migration and survival conditions for these non-listed Plan species, would be similar to those discussed previously for listed species (Sections 4.2.2.1 and 4.2.2.2 under Adult Migration/ Survival). Although the protection measures are expected to benefit all the Plan species, the extent of the benefit would vary by species.

Adult Reservoir Spawning

Under Alternative 3, changes in project operations would be primarily confined to structural changes at the projects, and are unlikely to substantially change river flow conditions. However, changes in spill patterns and volumes resulting from altered project operations to improve juvenile fish passage survival could alter downstream water quality conditions (Section 3.3.2). Potential effects on reservoir spawning of the Plan species under Alternative 3 are similar to those discussed previously in Section 4.2.3.2 under Adult Reservoir Spawning. These include water level fluctuations, sedimentation or scouring of spawning habitat, and elevated total dissolved gas levels.

Hatchery Production

Potential changes in hatchery production levels, and operational procedures affecting the Plan species are similar to those described in Section 4.2.3.1 under Hatchery Production.

Tributary Habitat Improvements

The procedures for making tributary habitat improvements would be the same as those discussed for the threatened and endangered species in Section 4.2.2.1.

Monitoring

Monitoring programs under Alternative 3 would be similar to those discussed previously in Section 4.2.2.1 under Monitoring, although they would also include specific survival studies for all the Plan species to verify that the HCP performance standards are being met. These studies would make substantial contributions to:

- quantify the impacts of project operations on all the Plan species,
- provide guidance to make appropriate structural and operational modifications at the projects to adequately protect these species, and
- assess the adequacy of the hatchery compensation levels at maintaining a no net impact on the Plan species.

This information would be used in an adaptive management approach, which would assess the benefits or results of the protection plans to conserve and/or recover each Plan species. This adaptive management approach is an essential part of the HCPs because the protection measures rely on survival results rather than strictly dam operation procedures (e.g., fish passage efficiency).

4.2.4.3 Resident Fish Species

Project Areas

There are no intended changes to project operations specifically aimed at resident fish species under either action alternative. Therefore the effects of project operations on resident fish in the project areas are not expected to differ substantially from either Alternative 2 or the existing conditions, with the possible exception of Pacific lamprey. As discussed previously, the potential increased use of turbine intake screens would increase the potential impacts to Pacific lamprey migrating past the projects because of their susceptibility to injury or impingement on intake screens. However, project operations are not expected to substantially impact other resident fish species. Salmonid species (particularly smolting fish) are generally more sensitive to environmental changes and more prone to physical injury (related to project passage) compared to most resident fish that occur in the project area. Therefore, bypass facilities designed to achieve a high level of salmonid passage survival would be unlikely to substantially impact resident species that pass the projects.

Associated Tributaries

Pacific lamprey spawn in low-gradient stream segments of smaller tributaries, including streams feeding the mainstem reservoirs. The low gradient segments of many of the Mid-Columbia River tributaries tend to occur in the lower watershed. These areas are also most likely to be impacted by land-use practices (primarily farms and orchards). Thus, tributary improvement projects in these areas are expected to benefit lamprey spawning and rearing.

Columbia River System

Discussions of the potential effects of project operations on resident fish species in the Columbia River system are provided in Section 4.2.2.3 under Resident Fish Species.

4.2.5 MITIGATION

As with Alternative 2, Alternative 3 provides no funds or specific provisions to address potential project impacts to bull trout, which is currently listed as threatened under the Endangered Species Act. Bull trout are known to occur in the project area, and have been observed passing the projects through the adult and juvenile fish passage facilities. The potential take of this species will require a separate consultation under Section 7 of the Endangered Species Act between FERC and USFWS. Any future listings of non-Plan species would also require separate Section 7 consultations under either of the action alternatives.

The HCPs provide a funding source for the improvement of tributary habitat that might be beneficial to non-Plan species, such as bull trout and Pacific lamprey. Although there are no plans or provisions to evaluate whether the habitat improvements benefit or impact non-Plan species, it is assumed that the Tributary Committee would consider non-Plan species in the determination of which habitat improvement projects to implement.

4.3 WATER RESOURCES (QUANTITY AND QUALITY)

4.3.1 WATER QUANTITY

4.3.1.1 Alternative 1 (No-Action)

Project Area

Over the next 50 years, the mainstem Mid-Columbia River dams would continue to be operated by the PUDs with the primary objective of power production. These dam and reservoir operations are generally based on instantaneous power demands, as described in Section 2.2.2. The number of turbines in operation and the resulting water discharge from each facility would continue to vary frequently, with typical daytime peak flows being about 135 percent of nighttime low flows. Flow releases from the Chief Joseph dam upstream are timed to increase power generation at downstream dams throughout the day. Hourly coordination among dam operators would continue to maximize generation efficiency by minimizing reservoir drawdown and maintaining optimal water levels for the turbines.

To maximize power production, Mid-Columbia River dam operators would continue to minimize the amount of water that is discharged over spillways. Forced spill would occur whenever the reservoir is at its normal maximum operating level and reservoir inflows exceed the hydraulic capacity of those turbines being used to meet the instantaneous power demand. When forced spill does occur, it would typically be at night when energy demand is lowest.

Associated Tributaries

Water quantities in the project area, Mid-Columbia River tributaries, and other reaches of the Columbia River may change due to climatic factors, modified water withdrawals, or changes in the operations of upstream storage reservoirs and tributary dams. Wet and dry climatic cycles are difficult to predict, as are the potential effects of global warming. These factors influence the amounts of precipitation and ultimately the river flows. There are currently no plans to change the operations of those projects upstream of the Wells Dam. Some future changes in tributary stream flows are likely to occur under Alternative 1 as irrigation withdrawals or other water uses change due to Federal, State, and local funding and regulations to protect threatened and endangered species in the tributary watersheds. However, such changes would be unrelated to PUD reservoir management.

Columbia River System

Because the three dams have very limited capabilities for water storage, these facilities have only a minor influence on flows in the Columbia River system. Under Alternative 1, the run-of-the-river reservoirs of the Mid-Columbia River region would continue to pass through water discharges from the Grand Coulee and Chief Joseph dams upstream. Water flows in the Columbia River downstream from the project area would continue to experience minor fluctuations based on turbine usage and spillway releases. Monthly flows and peak flows would not be affected by Alternative 1.

4.3.1.2 Alternative 2

Project Area

Monthly average flows and peak flows in the Mid-Columbia River and its tributaries are not expected to change under Alternative 2, beyond possible changes discussed under Alternative 1. The frequency and quantity of forced spills is also not expected to change from existing conditions.

To provide additional protection for listed species, measures to provide increased downstream passage of juvenile salmonids would be instituted under Alternative 2. These measures would include increased spill during specific migration time periods for the listed species. Reservoir drawdown, a measure to increase water velocities and decrease outmigration periods for juvenile salmon and steelhead, is a remote possibility for the next 50 years. Because of the limited storage capabilities of the reservoirs, these potential changes in dam operations would have only a minor and short-term affect on river flows. During spill events, a portion of the river flow is directed over the spillway rather than through turbines; however, the total quantity of water released from the dam is generally not affected.

If FERC licenses are amended to allow for drawdown, reservoirs could be drawn down by as much as 30 to 50 feet and water particle travel times would substantially increase.

Associated Tributaries

Similar to Alternative 1, changes in water quantities in the associated tributaries would be attributed to independent actions and not related to proposed Alternative 2 project plans.

Columbia River System

Alternative 2 would have a similar scenario as described under Alternative 1. Because reservoir drawdown would effect water velocity in the reservoirs but not change reservoir discharge rates, this possible action would also not effect Columbia River flows downstream from the project area.

4.3.1.3 Alternative 3

Project Area

Water quantity in the project area, under Alternative 3, would not be substantially different from Alternative 2. There are no proposed changes to operations at the three dams that would affect water quantity, and the development of juvenile fish bypass systems at Rocky Reach and Rock Island dams would likely be similar under both alternatives.

Improvements to the juvenile dam passage system could result in a reduction in the amount of spill at the projects, thereby reducing total dissolved gas levels. Although the bypass system at Rock Island Dam is based primarily on spillway passage, the focus is to increase the efficiency of spill (e.g., passing more fish with less water). At Rocky Reach Dam, improvements to the surface bypass system could decrease the use of spill. However, spill could also increase due to the need to meet the 95 percent survival standards.

Despite the potential changes in spill, these measures would not substantially alter water quantities (e.g., dam discharge rates, monthly flows, or peak flows) in the river. Modifications to the spill program or turbine systems would effect how the water passes a dam, but would not change river flows. Because of the very limited capability to store water in these run-of-the-river reservoirs, actions to avoid or minimize reservoir level fluctuations would have a limited influence on river flows.

Associated Tributaries

The water quantity in some Mid-Columbia River tributaries (i.e., the Wenatchee, Entiat, Methow, and Okanogan rivers) could be improved under Alternative 3 through tributary habitat improvements funded as part of the HCPs, compared to Alternative 2. In the selection of habitat improvement projects for funding, high priority would be given to the acquisition of land or interests in land such as conservation easements or water rights. These conservation measures would likely provide some improvements in tributary instream flow conditions, such as higher summer stream flows.

Most of the HCP habitat restoration strategies recommended for the Wenatchee River watershed center on efforts to maintain or increase the complexity of stream channels and floodplains (NMFS et al. 1998a). Benefits from several tributary riparian restoration projects include increasing late-summer instream flows and desynchronizing flood events. One specific proposal to move the diversion point for the East Wenatchee portion of Highline Canal to the Rock Island Pool would increase late-summer flows by 42 to 45 cfs.

Low flows in the lower Methow River limit salmonid production and survival during three seasons of the year (NMFS et al. 1998a). HCP recommendations to renovate the Methow Valley Irrigation District, enclose irrigation diversions in pipes to reduce evaporation and leakage losses, and support water conservation measures in tributary diversions would improve low flows in the Methow River watershed.

Water quantities in other tributaries of the Mid-Columbia River would not change under HCP habitat improvement strategies. Efforts to improve salmonid production in the Okanogan River drainage through facilitation and funding of improved agricultural practices would have little effect on flows. Recommended strategies for Entiat River habitat focus on improving structural complexity of the stream channel and improving woody debris recruitment. These HCP recommendations for the Entiat River watershed do not target instream flows and no changes in water quantity are expected to result from their implementation.

Columbia River System

Because the three dams have very limited capabilities for water storage, operational changes and mitigation measures designed to achieve HCP performance standards would have a negligible affect on flows in the Columbia River system. Under Alternative 3, the run-of-the-river reservoirs of the Mid-Columbia River would continue to pass through water discharged from the upstream storage reservoirs.

4.3.2 WATER QUALITY

4.3.2.1 Alternative 1 (No-Action)

Project Area

Mid-Columbia River water quality may improve over time as WDOE continues to work toward compliance with the Clean Water Act. For all Washington streams that are listed as having impaired water quality under Section 303(d) of the Clean Water Act, including the Mid-Columbia River and its tributaries, WDOE is required to develop and implement total maximum daily load limits to restore water quality for beneficial uses. The Mid-Columbia River in the project area is currently on the 303(d) list for total dissolved gas, water temperature, pH, and a water column bioassay.

Associated Tributaries

Water quality in the tributary rivers is also generally expected to improve over the next 50 years. In addition to WDOE efforts to develop and implement total maximum daily loads for compliance with the Clean Water Act, other agencies have undertaken watershed planning. These programs are critical to reverse the trend of water quality degradation. However, water quality is generally very good in the Mid-Columbia River tributaries so progress would be slow to result in measurable improvements. Because these tributaries produce only a small portion of the total Mid-Columbia River flows, improvements in water quality may not be noticeable in the larger river. Water quality is generally not the limiting factor in Mid-Columbia River tributary salmonid productivity, so water quality improvements would have a limited ability to help fish without other habitat improvements (e.g., increased summer low flows and channel structure improvements).

A watershed action plan and implementation schedule have been developed to promote water quality improvements throughout the Wenatchee River watershed from pollutant sources such as on-site sewage systems, agriculture, forestry, and stormwater (Wenatchee River Watershed Steering Committee 1998). The Chelan County Conservation District has initiated a watershed planning process for the Entiat River that includes water quality evaluations in 2000 (Jones 1999). Alternatives to enhance fish habitat by restoring riparian vegetation, if implemented, would provide increased shade and may reduce high summer water temperatures. Efforts to improve instream flows through improved conservation practices in the Methow River watershed (Methow Valley Water Pilot Planning Project Committee 1994) may also improve water temperatures and other water quality constituents.

In the Okanogan River watershed, the Okanogan Conservation District and Okanogan County have joined with other agencies and interested parties to draft a plan that addresses non-point and point source pollution and identifies implementation strategies (Okanogan Watershed Stakeholder's Advisory Committee & Technical Advisory Committee 1999). Actions identified in this draft plan directly address water quality improvements for constituents identified on the 303(d) list: water temperature, dissolved oxygen, fecal coliform bacteria, pH, dicholoro-diphenyl-tricholoroethane (DDT), PCBs, arsenic, instream flows, and turbidity and sediment.

Riparian reserve protection and other land management improvements on USFS lands may further improve water temperatures, dissolved oxygen concentrations, sedimentation, and other water quality variables in Mid-Columbia River tributaries. These efforts to improve water quality are expected to continue and result in incremental water quality improvements over time.

Columbia River System

The run-of-the-river projects of the Mid-Columbia River generally convey unpolluted, high-quality water from the upper reaches and tributary rivers to downstream reaches of the Columbia River. Marginal improvements are likely as WDOE implements total maximum daily loads for specific water quality parameters that exceed standards, and as other agencies and watershed protection organizations work to enhance water quality and improve instream flows.

4.3.2.2 Alternative 2

Project Area

Of the Mid-Columbia River water quality constituents on the 303(d) list, total dissolved gas is directly affected by project area dam operations. Increased spills to facilitate juvenile salmonid migrations have the potential to increase total dissolved gas concentrations under Alternative 2. For example, if 95 percent survival is required for endangered salmonid species passing the Rocky Reach project, then it may become necessary to divert more water to the spillway to increase survival. Conversely, actions responding to WDOE requirements and voluntary mitigation efforts by the PUDs (e.g., spill deflectors) are likely to reduce total dissolved gas downstream from the dams.

To comply with the Clean Water Act, either the spillways would be modified to reduce total dissolved gas levels to no more than 110 percent saturation, or WDOE would grant waivers of the 110 percent total dissolved gas saturation standard to allow 115 percent saturation in project forebays and 120 percent saturation in tailraces to improve fish passage over the spillway.

Other water quality constituents on the 303(d) list for the Mid-Columbia River project area are generally not expected to change under Alternative 2. Because high dams upstream (e.g., Grand Coulee Dam) are not equipped to release cooler water from deep in the reservoirs, and because the project area reservoirs are run-of-the-river projects that warm up and cool off quickly with ambient temperature changes, little can be done to improve high summer water temperatures. The 303(d)decision matrix indicates that the pH listing was based on two excursions beyond the criterion in 1991, and remedies to the problem may not be available (WDOE 1996).

If reservoir drawdown is implemented to hasten juvenile salmon and steelhead outmigration in the spring, some marginal changes in water quality could occur. Measurable changes in water temperature are not expected to occur under the drawdown scenario. Some localized short-term increases in turbidity and suspended solids, re-suspension of pollutants, increased nutrients, and possible downstream reductions in dissolved oxygen could occur, depending on the extent of drawdown. These impacts would dissipate over time and water quality would return to pre-drawdown conditions.

Associated Tributaries

Alternative 2 would have no effect on water quality in the Mid-Columbia tributaries.

Columbia River System

Alternative 2 is similar to effects described under Alternative 1 for most water quality parameters. In addition, one water quality parameter that could be affected by Alternative 2 is total dissolved gas. There is a cumulative increase in the levels of total dissolved gas supersaturation as a result of spilling from the series of dams in the system; thus, any reduction in total dissolved gas achieved at Mid-Columbia River dams would benefit water quality downstream. Conversely, if spills are increased to facilitate juvenile salmonid migration, total dissolved gas supersaturation could increase. Further research would better define the risks of gas bubble disease and other adverse effects caused by total dissolved gas supersaturation under different conditions. It is unlikely that increased spills would be allowed until it is demonstrated that risks of adverse effects to fisheries and water quality are acceptable.

4.3.2.3 Alternative 3

Project Area

Similar to Alternative 2, water quality in the Mid-Columbia River may improve over time under Alternative 3 as WDOE implements total maximum daily load limits for parameters that do not meet water quality standards. Efforts to meet the 95 percent survival standards for all species may include diverting more river flow to spillways where fish survival is generally higher than other bypass options. Increasing spill levels to improve survival rates is more likely at Rocky Reach and Rock Island dams than Wells Dam because of the efficiency of the Wells Dam surface bypass system.

Increased spill to improve fish survival could result in higher total dissolved gas supersaturation, thereby conflicting with efforts to meet the water quality standards for total dissolved gas. However, the Rock Island and Rocky Reach HCPs also commit the PUDs to take measures that maintain total dissolved gas levels at or below legal maximum levels, except when regional flood control operations cause flows to exceed the project capacities to control spill levels. Some combination of mitigation to reduce gas entrainment at spillways (e.g., spill deflectors) and changes or waivers for the 110 percent saturation limit would likely be necessary to meet HCP commitments to both the fish survival and water quality standards.

Associated Tributaries

The tributary habitat improvement projects funded by the HCPs are expected to benefit water quality. For example, water conservation measures that increase summer low flows would also lower water temperatures and improve dissolved oxygen conditions during this critical time of the year.

Columbia River System

Existing water quality in the Columbia River would be maintained under Alternative 3, with some marginal improvements as various watershed and water quality programs are implemented. Because of the cumulative increase in total dissolved gas supersaturation that results from spilling water from the series of dams in the system, reductions in total dissolved gas achieved through HCP measures would benefit water quality downstream. Any other effects on water quality of the Columbia River system as a result of Alternative 3 are expected to be negligible.

4.4 VEGETATION

4.4.1 ALTERNATIVE 1 (NO ACTION)

4.4.1.1 Project Area

Ongoing operations at the three dams would have no effect on vegetation (including wetlands) within the project area. There are no plans to change water levels beyond existing conditions under any of the FERC licenses.

4.4.1.2 Associated Tributaries

Planned projects that are outside of the jurisdiction of the PUDs would affect vegetation located in the watersheds of the four tributaries. As part of the Federal- and State-mandated WRIA and USFS habitat improvements that are occurring, riparian habitat along the associated tributaries would be acquired for preservation, enhancement, and restoration. Larger buffer areas along the stream corridors would be set aside and converted from existing land uses (largely agricultural) to riparian habitat.

Habitat improvements would involve the removal of non-native or agricultural plant species, adding or enhancing soils, and planting native riparian, wetland, or upland overstory vegetation. Habitat conservation areas may also be protected from human intrusion. These actions would have a beneficial effect on vegetation by removing non-native species, converting disturbed areas back to a more natural state, and increasing plant survival rates. These projects are independent of the three dams, and would occur regardless of the alternative selected under the Endangered Species Act.

4.4.1.3 Columbia River System

There are no planned changes in vegetation throughout the Columbia River systems dams that would affect Wells, Rocky Reach, or Rock Island project vegetation.

4.4.2 ALTERNATIVE 2

4.4.2.1 Project Area

Under Alternative 2, the three projects would implement measures to improve adult and juvenile fish passage past the dams, continue the funding of the hatchery programs, monitor and evaluate the success of fish passage measures, and analyze the potential for fish survival and recovery with the proposed measures. Some of the actions that would be implemented at the dam sites include modifying ladder operations, in particular improving the entrances to the ladders; operating the surface bypass system continuously during migratory periods; operating turbines at peak efficiencies, and implementing a predator removal program and gas abatement program. The actions associated with dam facility improvements are in-water improvements and would have no adverse effect on shoreline vegetation.

The increased program of spills at the dams during fish migratory periods would also have no adverse effect on shoreline vegetation. This is because there would be no change to the existing water level fluctuations (3 feet at Rock Island and Rocky Reach and 7 feet at Wells) downstream of the three dam sites.

Another potential (but remote) operational change that could occur over the next 50 years may be to drawdown reservoirs as part of NMFS' regulatory authority to ensure salmon and steelhead survival. Drawdown would affect riparian zone vegetation and wetlands located near the reservoirs, as well as aquatic bed vegetation. The relatively static nature of the water levels in the reservoirs has resulted in the formation of wetlands and mature riparian vegetation in those areas that are not developed for orchards, other agriculture or development, or rip-rapped to prevent erosion. Drawdown would result in the short-term loss of riparian, aquatic, or wetland vegetation because these vegetative types are dependent on being saturated or located near a constant water supply. Over time, wetlands in new shallow areas would become established.

One rare plant species could also be impacted by the potential drawdowns of the reservoir pools. The giant helleborine is known to occur on or near the three reservoir shorelines.

4.4.2.2 Associated Tributaries

Implementation of Alternative 2 would have no effect on vegetation within the tributaries.

4.4.2.3 Columbia River System

Dam facility improvements would not affect vegetation elsewhere in the Columbia River system.

4.4.3 ALTERNATIVE 3

4.4.3.1 Project Area

Impacts to vegetation along the project reservoir shorelines would be similar to those described under Alternative 2 for the protective measures planned at the project sites. Because drawdown is not a protective measure planned under the HCPs, vegetation effects from this option would not occur.

4.4.3.2 Associated Tributaries

Tributary Plan improvements would include land acquisition and habitat improvement of shoreline areas along the four tributaries. Additional money would be available under the HCPs and thus a greater level of habitat restoration would be possible. Some of the main areas where riparian vegetation has been recommended for protection and restoration include the following:

- Wenatchee watershed
  - Lower White River
  - Lower Wenatchee River
  - Lower Peshastin Creek
  - Lower Nason Creek
  - Lower and Upper Icicle Creek
  - Chumstick Creek
  - Ingalls Creek
  - Negro Creek

Camas Creek
Mission Creek
Brender Creek

- Entiat watershed
  - Lower Entiat
  - Mud Creek
  - Mad River
  - Preston Creek
  - Fox Creek
  - Stormy Creek
  - Roaring Creek
- Methow watershed
  - Lower Gold Creek
  - Lower Twisp River
  - Lower Chewuch River
  - Lower Benson Creek
  - Lower Lost River
  - Upper and Lower Methow
  - Beaver Creek
  - Hancock Creek
  - Wolf Creek
- Okanogan watershed
  - Upper mainstem Okanogan River
  - Lower Similkameen River

4.4.3.3 Columbia River System

There would be no changes to vegetation in the rest of the Columbia River system under Alternative 3.

4.5 WILDLIFE

4.5.1 ALTERNATIVE 1 (NO ACTION)

4.5.1.1 Project Area

Wildlife habitat enhancement and monitoring (e.g., installation and monitoring of Canada geese nesting structures and wood duck nest boxes) at the project locations are currently conducted according to FERC licensing agreements, as well as on a voluntary basis. These activities would continue under the no-action alternative. The PUDs will also continue to work at reducing the number gulls feeding on juvenile salmon at the dams. There are no threatened and endangered species affected by current licenses.

4.5.1.2 Associated Tributaries

Due to the presence of threatened and endangered fish species in the associated tributaries, a variety of habitat improvements are likely to take place through independent agency actions in the associated tributaries. Watershed action plans are currently underway in the four tributaries, and include habitat protection, preservation, and improvement projects. These activities (funded by Federal, State, and local entities) include both in-stream enhancement and riparian habitat and floodplain restoration and enhancement.

During the season of construction, these activities would cause short-term noise and visual disturbance. Wildlife species would either be lost or displaced to other areas during the time of disturbance. However, most species would return to the area upon completion of the construction activities. Projects may also cause a short-term loss of habitat, as construction equipment and use may destroy existing vegetation. Cleared areas would likely be re-planted with native vegetation that provide optimum conditions for large woody debris entry into adjacent streams. Short-term disturbance could occur to bald eagles; however, over the long-term, the habitat improvements would increase the number of bald eagle prey. Riparian habitat improvements are likely to increase waterfowl foraging and nesting habitat.

Apart from the short-term disturbance to wildlife, these tributary projects would improve conditions for wildlife, depending on the types of projects that occur. Plantings of riparian vegetation would provide increased nesting, foraging and breeding habitat for riparian-associated birds, and forage and cover for beaver, as well as deer and other land mammals. Changes to stream hydrology that could occur with habitat improvement projects, such as creation of eddy and backwater areas, would improve foraging and breeding habitat for waterfowl and amphibians. Improvements in salmon and steelhead spawning habitat, and concomitant increases in spawning salmon, would represent an increase in prey availability for black bear, river otter, and turkey vultures and other carrion-eating birds.

4.5.1.3 Columbia River System

There are no changes in the Columbia River system that would affect wildlife populations at the three dams.

4.5.2 ALTERNATIVE 2

4.5.2.1 Project Area

For Alternative 2, likely fish protection and enhancement actions that would take place at the dams would have a negligible effect on wildlife, including Federally proposed species, a species of concern, State-listed species, State candidate species, or state monitor species. Because wildlife species do not pass through the dams, improvements to adult fish passage (e.g., hydraulic and structural fishway modifications, improvements to juvenile passage from changes to spill programs and installation [Rocky Reach and Rock Island Dams], and modification [Wells Dam] of permanent juvenile bypass facilities) would have no direct effect on wildlife. However, fish passage improvements at the dams could indirectly affect gulls. Disoriented juvenile salmonids are a significant source of prey for gulls, which concentrate around the dams during juvenile salmonid migration.

If improvements to juvenile bypass systems cause less disorientation to juvenile fish, gull prey availability in the tailrace would be reduced. This reduction in prey availability, combined with the intensification of avian predator control measures (such as installing more gull wires and increasing gull hazing activities) may result in a decline in gulls in the vicinity of the dams.

Other wildlife species that occur in the project area do not depend on juvenile or adult salmon and steelhead as prey, and thus would not be indirectly affected by improved fish passage at the dams. Mink do prey on salmonids, but other prey (other fish, birds, and mammals) constitute the majority of their diet, and changes in salmonid abundance or passage rates at the dams would not affect mink populations in the area (Verts and Carraway 1998). River otters prey on fish to a greater extent than mink, but for otters in the vicinity of the dams and reservoirs, slow-moving resident fish (such as northern pikeminnows and suckers) likely comprise the majority of their fish prey (Toweill and Tabor 1982). Consequently, changes in salmonid prey availability would have a negligible effect on river otters in the vicinity of the dams (Verts and Carraway 1998).

In the unlikely event of drawdown, impacts would depend on the timing, extent, and duration of drawdown. Waterfowl would be affected through reductions in plant forage, invertebrate prey, and nesting/brood-rearing backwater areas, and an increase in predator access to nest sites. Impacts of drawdown to amphibians would include stranding of egg masses and loss of breeding and foraging habitat. Den sites of aquatic furbearers would be lost through lowering of the river water level, and these species could also be impacted by reductions in food availability (i.e., riparian and aquatic vegetation, and resident fish species).

4.5.2.2 Associated Tributaries

As with Alternative 1, a variety of independent habitat improvements are likely to take place that could improve wildlife habitat over time.

4.5.2.3 Columbia River System

Fish protection measures and habitat improvements would occur in only a small portion of the Columbia River system, and significant changes to wildlife or wildlife habitat over the entire region are not expected to occur.

4.5.3 ALTERNATIVE 3

4.5.3.1 Project Area

As with Alternative 2, likely fish protection and enhancement actions that would take place at the dams under Alternative 3 would have negligible effect on wildlife.

4.5.3.2 Associated Tributaries

Habitat improvements under Alternative 3 would include funding projects similar to tributary habitat improvements as currently planned by other resource agencies. Projects funded by the HCPs would include both habitat protection and habitat restoration. Habitat protection projects would focus on maintaining existing floodplain and riparian areas. Such actions would prevent these areas from being converted to residential and other developments. Consequently, although these types of projects would not represent an immediate benefit for wildlife, the projects would prevent riparian and floodplain habitat loss. As such, habitat protection projects associated with the HCPs would have long-term benefits for riparian- and aquatic-associated wildlife (including waterfowl, aquatic furbearers, riparian-associated songbirds, and other species such as deer and black bear that use riparian habitats intermittently). Habitat protection projects that would have the most benefit to wildlife are projects in areas that currently contain good wildlife habitat (i.e., presence of riparian trees and shrubs and good aquatic habitat) but are threatened by development.

Habitat restoration projects would include enhancing riparian habitat, restoring floodplain function, and improving fish passage to wetlands. Riparian and aquatic habitat improvements would cause a short-term disturbance to wildlife in the vicinity, but would have long-term benefits to songbirds, raptors, waterfowl, aquatic furbearers, amphibians, and land mammals that occasionally use riparian habitats. One possible exception to beneficial effects of habitat improvements is the impact of fish introductions on amphibians. If fish passage is improved such that resident fish gain access to areas that are currently occupied by amphibians but devoid of fish, impacts to amphibians could occur. Fish prey on amphibians and can cause local declines or extinction in amphibian populations (Blaustein and Wake 1990; Corn 1994). Habitat restoration projects that would have the most benefit to wildlife are those that involve restoring riparian vegetation and improving wetland and backwater habitats.

4.5.3.3 Columbia River System

There are no expected changes in the Columbia River system that, in combination with Alternative 3, would result in an overall change in wildlife abundance or habitat.

4.5.4 MITIGATION

Efforts should be made to minimize disturbance impacts to wildlife from construction activities associated with tributary habitat improvements. Before construction occurs, WDFW should be consulted to determine if threatened, endangered, or other sensitive wildlife species occur in the vicinity, and appropriate measures to minimize disturbance should be undertaken.

4.6 LAND OWNERSHIP AND USE

4.6.1 ALTERNATIVE 1 (NO ACTION)

4.6.1.1 Project Area

Existing FERC licenses for the three dams would not alter land uses in the vicinity of the project area.

4.6.1.2 Associated Tributaries

As part of the Federal, State, and local watershed improvements that have been identified to improve endangered fish habitat, land along the shorelines of the tributaries may be acquired for preservation and restoration. This would convert existing private land ownership to public land and change the main land use (agriculture) to natural habitat. There are several other land use implications of this change in ownership: (1) there would be less access to the shoreline areas for recreation, (2) there would be no additional residential development along the shoreline, and (3) no industrial uses would be allowed near the shoreline.

Historical floodplain areas could return to floodplain conditions to provide increased salmon habitat. There may be some areas where the rivers or streams would be allowed to flood naturally. Many of these areas that have been protected from flooding and land uses (such as homes or agriculture) occur in floodplains. As part of allowing flooding to occur, there may be areas where the existing land uses (such as residences) could be displaced, and these properties would be acquired. These activities would occur regardless of the alternative selected under the Endangered Species Act for the three projects.

4.6.1.3 Columbia River System

There are no known changes in land uses in the Columbia River system that would affect continuing operation of the three dams.

4.6.2 ALTERNATIVE 2

4.6.2.1 Project Area

Protection measures for fish migrating past the dams would include hydraulic and structural fishway improvements to allow for increased upstream passage by adult fish, such as modifications to ladders and changes in water flow to attract fish. Measures would also be implemented to increase the downstream passage of juvenile salmonids (such as increased spill programs, improved fish bypass systems, expanded predator control devices, and improvements to reduce dissolved gas levels). The planned structural and facility improvements at the dam would not change predominant adjacent land uses: power production, fish survival and production, and tourism. However, other potential dam operations (such as drawdowns) would change agricultural land uses particularly along the shorelines and on the river itself.

Drawing down the reservoirs would make it considerably more difficult to obtain irrigation water for agriculture. Inflow lines would be extended and larger pumps would be needed. This work would require a one-time capital cost, and would also increase yearly maintenance costs. In addition, less water would be available for irrigation because the water would be needed for fish passage. These factors would result in loss of irrigated agricultural lands in the vicinity of all three dams. Under the current State of the agricultural economy in the region, these additional costs would be very difficult for the farmers to provide. This would likely result in a further reduction in the economy of the region.

4.6.2.2 Associated Tributaries

Alternative 2 would not affect any land use along the associated tributaries.

4.6.2.3 Columbia River System

Dam facility improvements would not affect agricultural land uses elsewhere in the Columbia River system.

4.6.3 ALTERNATIVE 3

4.6.3.1 Project Area

Land use at the three dams would not significantly change under Alternative 3. While there would be modifications to structures and operation of the dams to improve fish passage and survival, the land use would remain oriented to power production, fish survival and production, and tourism. Similarly, land uses in the vicinity of the three dams would be unaffected, because none of the on-site modifications would impact any off-site areas near the dams or reservoirs.

4.6.3.2 Associated Tributaries

The Plan Species Account could provide money to acquire easements or purchase property for habitat improvements along the four main project tributaries. This work would be in addition to the Federal, State, and local effort to preserve or enhance habitat. Habitat improvements would largely focus on the shoreline environments that presently are used extensively for agriculture, but may also include some scattered residential and commercial land uses. Protecting these areas would require the acquisition of land along the shoreline and conversion from its present land use to an undisturbed shoreline buffer. This buffer area would likely be a formally designated land use type similar to a Native Growth Protection/Conservation Easement. Certain types of activities, such as farming, would then be prohibited from occurring within the buffer area.

It is not possible to predict the extent of land acquisition and conversion to the shoreline buffer at this time, because off-site habitat compensation measures have not yet been fully evaluated and land values for particular land acquisitions have not been determined. However, the three dams would make a yearly contribution to the Plan Species Account, and there is a significant opportunity to provide meaningful off-site habitat improvements for fish through these land acquisitions. As a result of this funding, there would be some shoreline areas along the four tributaries acquired for this purpose. Agricultural areas are likely candidates for conversion to shoreline habitat, as well as floodplains (as discussed previously).

The types of land ownership potentially affected by land acquisition includes private ownership particularly in the lower reaches of the Wenatchee, Entiat, and Methow rivers, and most of the Okanogan River, except for the Colville Indian reservation lands along the lower reaches of the Okanogan River. There are also some scattered public lands administered by the BLM and State-owned lands located along the Entiat, Methow and Okanogan rivers. National Forest lands line the shores of the upper reaches of the Wenatchee, Entiat, and Methow rivers.

4.6.3.3 Columbia River System

Alternative 3 would not directly cause significant changes in land use in the rest of the Columbia River system.

4.6.4 MITIGATION

Projects planned under the Plan Species Account that could affect downstream floodplains on agricultural, industrial, commercial, or residential lands would require an impact evaluation with specific mitigation measures applied to these properties, excepting the properties that are directly purchased to increase fish habitat. The specific mitigation measures needed would be project specific. Evaluations should occur during project planning and design.

4.7 SOCIOECONOMICS

4.7.1 ALTERNATIVE 1 (NO ACTION)

Socioeconomic impacts can be either direct or indirect. Direct impacts result when employment or expenditures in an industrial sector either increase or decrease. For example, when a new manufacturing plant moves into an area and hires new workers. Indirect economic impacts result when one industry purchases goods and services from another. For example, when a manufacturing plant closes, income to restaurants may be affected because there are fewer workers eating meals out.

Employment and economic activity is supported by the three hydroelectric projects in several industrial sectors. Employees working at the dams and hatcheries are either government employees or contract personnel, and overall, are an important part of the local economies (see Table 3-12). Project area construction workers usually live in the general project area and indirectly support the local economy.

Scientific research and engineering studies for the projects are often conducted outside of the three counties by service sector employees in the Puget Sound or Tri-Cities area. This employment sector is relatively larger statewide than in the project counties. This activity has relatively little affect on the local economy.

The hydroelectric projects also support agricultural employment by providing a source of irrigation for orchards near the reservoirs. Agricultural employment is a very important component of the local economy, in both direct and indirect employment. Although irrigation could occur without the hydroelectric projects, significant modifications to the existing facilities would be required.

4.7.2 ALTERNATIVE 2

Most current activities at the three hydroelectric projects would continue under Alternative 2. There would be little, if any, change in the direct and indirect employment related to the projects. Hatcheries would continue operating at their current level. Continued operation and maintenance of the facilities, and modifications to improve fish passage, would provide employment in the government and construction sectors. On-going studies and research would be required to evaluate and monitor how the projects affect spring-run chinook salmon and steelhead. Overall, no significant changes in employment and economic activity are likely under Alternative 2.

However, the possibility of additional future protective measures over the next 50 years under Section 7 of the Endangered Species Act remains open. These measures could require structural and operational modifications to the projects that would affect recreational activities. If the projects are required to operate at minimum pool levels to improve fish passage, recreational activities would be significantly reduced. This would have a significant adverse affect on the local county economies.

If drawdown occurs, reduced pool elevations would also affect irrigation for adjacent agricultural areas, primarily fruit orchards. Many water withdrawal systems would have to be modified to reach the lower water level, resulting in a one-time capital cost. Lower water levels would also require more energy to operate the pumps, increasing operating costs. Increased costs could cause some orchards to go out of business. The impact would affect Douglas and Okanogan counties more than Chelan. Since agriculture is a primary industry for these areas, there would be a substantial impact on other businesses in the area. The economic impacts of Alternative 2 could be severe if pool levels were substantially reduced. However, the likelihood of implementing drawdown is low.

4.7.3 ALTERNATIVE 3

Similar to Alternative 2, most current activities at the three hydroelectric projects would continue under Alternative 3. Operation and maintenance of the facilities, and modifications to improve fish passage, would be similar to current activities and would continue to provide employment in the government and construction sectors. The continued funding for hatchery operations would not have any economic impacts because it is a continuation of existing expenditures and therefore would not create new jobs or have other economic impacts. On-going studies and research, to monitor and evaluate the effects of the hydroelectric projects on survival and recovery of anadromous salmonid species, would be required for the 50-year term of the HCPs. Chelan PUD does much of the monitoring and evaluation in-house. When consultants are used, they are regularly hired from the local workforce.

The proposed action includes new funding of off-site activities to increase salmonid productivity in areas other than the project reservoirs and facilities. A Plan Species Account would be established and supported with contributions from each of the PUDs. Money would be provided to acquire mitigation sites, and support operation and maintenance of off-site mitigation measures. The habitat improvements likely to result from this project would be carried out by the general construction industry.

The funding for off-site measures would bring new expenditures into the area, create new jobs, and provide new income. The expenditures would most likely be in the construction industry in the three project counties (Chelan, Douglas, and Okanogan). For the Wells project, the Douglas County PUD would make an initial contribution to the Fund of $991,000. The expenditure would generate eight jobs in the local construction industry and 21 total jobs in the region. If after 5 years of study project survival remains at or above 95 percent, the PUD will make annual payments of $88,089 (1998 dollars) through the term of the HCP. This funding would generate one construction and two total jobs in the region. If survival is below 95 percent, an additional $991,000 would be provided and the annual funding would increase to $176,178, which would double the economic effect described previously.

For the Rocky Reach project, Chelan County PUD would fund the Plan Species Account at $229,800 (1998 dollars) annually. This funding would generate two construction and five total jobs in the region.

For the Rock Island project, the Chelan County PUD would fund the Plan Species Account at $485,200 (1998 dollars) annually. This funding would generate 4 construction and 10 total jobs in the region.

The new expenditures for off-site habitat improvements would have a very small positive impact on the local economies. Since the combined labor force for the three counties was 63,679 in 1998, even a maximum increase of 38 jobs would not be significant.

Alternative 3 would also provide economic benefits by insuring the projects could continue to operate in a manner that supports agricultural and recreational activities. The role of recreation in the local economies is discussed in Section 3.8.

4.8 RECREATION

4.8.1 ALTERNATIVE 1 (NO ACTION)

Under the current licenses and amendments including the recreation plan [(Wells: FERC 1962a, 1962b, and 1882), (Rocky Reach: FERC 1953, 1957a, 1957b, and 1976) and (Rock Island: FERC 1975a, 1987, and 1989b)] there would be no impacts to recreational facilities or opportunities, from construction and implementation of fish passage improvement measures. The recreation plans for the projects are updated every 5 years and can be revised to accommodate changing recreational needs.

Although no changes are expected to occur to recreational facilities within the project area, recreational access and facilities could be affected by the ongoing WRIA projects and watershed action plans in each of the tributaries over the next 50 years. These projects would likely decrease some recreational use in the tributaries through purchase of shoreline easements for fish habitat protection and restoration.

4.8.2 ALTERNATIVE 2

For Alternative 2, protective measures that would be implemented in the near term include modifications to equipment at the dams. Recreational use in the immediate vicinity of the dams is limited to shoreline observations. Additional protective measures may be required in the future if the proposed measures are not as successful as intended in decreasing salmon and steelhead mortality or if new fish species are listed.

4.8.2.1 Project Area

For planned and known actions that would occur under Alternative 2, there would be few, if any, changes to recreational activities or facilities due to structural improvements or modifications. At all three dams, existing fishways, ladders, and bypass systems would continue in operation and be maintained to increase efficiency. None of these actions would affect recreation, except for potential brief closures of public viewing areas near the structures during project construction.

Over the long-term, the most significant action that could potentially occur would be drawing down any or all of the projects to natural river levels. This action could have substantial impacts on recreation. Without modifications, the lower water levels would render boat ramps, docks, and beaches unusable from April through August when peak recreational activity occurs. This would be a substantial loss of recreational facilities, if not modified, potentially affecting a large number of users[1]. The lower water level would also indirectly affect recreation by reducing the aesthetic qualities of the waterfront areas. The lowered pool would expose an unvegetated area of silt, sand, and rock. The loss of aesthetic quality could result in substantially lower recreational activity until the shoreline areas were revegetated.

Impacts to recreation from drawdown at the Rock Island reservoir would be low to moderate. In the Wenatchee River, the potential change of 2.5 feet would probably not cause substantial aesthetic impacts to views from Riverfront Park. Parks affected near the Rock Island reservoir include Riverfront Park, Wenatchee Confluence State Park, and Rock Island Hydro Park. The boat ramps and beaches would not be usable, unless modified.

There are five public parks located near the Rocky Reach reservoir (Lincoln Rock State Park, Orondo

[1] The total number of visitors to parks in the project area are known. Data that distinguish between water-dependent uses, such as boating, fishing, and swimming, and non-water dependent uses such as picnicking or camping are not available. Therefore, the number of recreational users that would be affected cannot be calculated.

State Park, Daroga State Park, Entiat Park, and Beebe Bridge Park). In addition to the temporary loss of the boat ramps and beaches, the lower level would also have aesthetic impacts and indirectly reduce recreational activity. At the Wells reservoir, Pateros Memorial Park, Columbia Cove Park, Brewster Waterfront Trail, and Bridgeport Marina Park would be affected by losing their waterfront setting. The parks would instead front an expanse of silt, sand, and rock.

The loss of recreational opportunity and setting would result in a corresponding loss in recreation expenditures, employment, and tax revenues, at least in the near-term. Recreational expenditures are important to Chelan and Okanogan counties, but most of the recreational opportunities are located in mountain and upland settings away from the project area and would not be affected. Of the 80 total boat launches in Okanogan County, only the five launch lanes located in Pateros Memorial Park, Columbia Cove Park, and Bridgeport Marina Park could be affected. In Douglas County relatively more facilities could be affected (for example, 12 of 15 total boat launch lanes).

Drawdown may however, increase fishing opportunities in the project area over the long-term. Boaters could navigate larger areas within the river system assuming the ability to move through a dam once drawdown occurs.

4.8.2.2 Associated Tributaries

No changes in recreational facilities or access are expected to occur from implementation of Alternative 2.

4.8.2.3 Columbia River System

Considering the known protective measures planned at Wells, Rocky Reach, and Rock Island dams, there would be no changes to recreational uses either upstream or downstream of these dams. However, if drawdown occurs under Alternative 2, recreational uses downstream of the three dams would be limited, particularly at Wanapun and Priest Rapids dams. The affect of drawdown would decrease the further downstream from the dams, assuming that the downstream dams are not also drawing down water levels.

4.8.3 ALTERNATIVE 3

4.8.3.1 Project Area

The protective measures planned under Alternative 3 would have no effect on recreational activities or facilities in the project area. Similar to Alternative 1, modifications and improvements to improve fish passage would not alter recreational use, except for brief closures of public viewing areas during construction.

Compared to Alternative 2, pool level fluctuations in the three reservoirs would continue to be similar to existing conditions. Stable and predictable water levels generally benefit recreational users and would not affect recreational facilities.

4.8.3.2 Associated Tributaries

Habitat improvements proposed under the HCPs could temporarily affect some recreational activities along project tributaries. Access for fishing may be restricted over the short-term while improvements are constructed and possibly for a short time thereafter to allow vegetation to become reestablished. These restrictions would be temporary and probably would not last more than one season. The overall impact would not be significant.

Recreational access could be permanently restricted on some properties if purchased for habitat improvements. These restrictions would serve to protect streamside vegetation and fish habitat. The area affected for these future projects is not known, but is likely to be restricted to streamside vegetation.

Over the long-term, habitat improvements in the tributaries would probably benefit other game fish, such as trout. This would improve recreational fishing opportunities and indirectly benefit the local economies.

4.8.3.3 Columbia River System

No changes to recreation on the Columbia River system are expected as a result of Alternative 3.

4.9 CULTURAL RESOURCES

In general, cultural resources must be at least 50 years old to be eligible for the nation's inventory of historic places, known as the National Register of Historic Places (National Register). The types of properties listed in the register include archaeological sites and buildings and structures, as well as traditional cultural properties or places that are associated with a community's historically rooted beliefs, customs, and practices. Cultural resources dating to the last 50 years do not meet the National Register criteria unless they are of exceptional importance. This exception is described in the National Park Service Bulletin No. 22, *How to Evaluate and Nominate Potential National Register Properties That Have Achieved Significance Within the Last 50 Years*.

The National Historic Preservation Act and the NEPA require the consideration of historic resources prior to projects affecting the environment. Section 106 of the National Historic Preservation Act requires that projects with Federal involvement take into account the effects such actions would have on properties that are listed in or eligible for the National Register. The NEPA indicates that it is the "responsibility of the Federal government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs and resources to the end that the Nation may…preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity, and variety of individual choice."

The following sections of this report address the impacts that the proposed project would have on properties eligible for the National Register and provide mitigation measures for potential impacts. A significant adverse impact occurs to cultural resources when the characteristics that make a property eligible for the National Register are diminished or destroyed. A significant adverse effect also occurs when an undertaking causes irreversible damage or destruction to a historic site or its setting. The area of potential effect, or geographic area within which the proposed project may impact cultural resources, includes the dams themselves and the reservoirs behind Wells, Rocky Reach, and Rock Island dams, and portions of the Wenatchee, Entiat, Methow, and Okanogan drainage basins.

4.9.1 ALTERNATIVE 1 (NO ACTION)

4.9.1.1 Project Area

Wells Dam

Under the current license (1963) and amendments (1982) there would be no new impacts to cultural resources. As outlined in Chapter 3, data recovery occurred in 1982 to mitigate for the inundation of 13 National Register-eligible archaeological sites. Additional archaeological sites adjacent to the reservoir could undergo impacts due to ongoing natural processes and human use of the reservoir. Archaeological sites could undergo potential impacts due to ground disturbances such as, erosion, vandalism, artifact collection, and vehicle use across archaeological sites. Because no historically significant buildings or structures are located within the study area, there would be no ongoing potential impacts to buildings and structures. Under the current license, the Douglas County PUD has developed a Memorandum of Agreement to address such impacts.

Rocky Reach Dam

Under the current license for Rocky Reach Dam, no new impacts to cultural resources are anticipated. The ongoing impacts caused by natural processes and human actions noted in the previous discussion for Wells Dam could also affect cultural resources within the Rocky Reach Dam study area. As described in Chapter 3, the current Rocky Reach Dam license issued in 1957 originally included minimal stipulations regarding the management of cultural resources. In 1983, the license was amended to include Article 49, which designates protection measures including consultation with the State Historic Preservation Officer regarding construction projects that could impact cultural resources. As part of the Chelan County PUD's relicensing of the Rocky Reach Dam, it will develop a cultural resource management plan (Salter 2000).

Rock Island Dam

No new impacts are anticipated under the current license for the Rock Island Dam license, issued in 1989. Under this license the Chelan County PUD created a cultural resource management plan to address the management of cultural resources associated with the project. The ongoing impacts due to natural processes and human use that are listed in the previous discussion for Wells Dam also apply to Rock Island Dam. Under the current license, such impacts would be addressed according to management processes stipulated in the Cultural Resource Management Plan.

Associated Tributaries

Independent tributary enhancements may affect cultural resources along the shorelines of the four tributaries. However, these projects are likely to require environmental review and permitting that will ensure that cultural resources are protected during construction and over the long-term.

Columbia River System

There are no expected changes to cultural resources from cumulative activities planned within the Columbia River system.

4.9.2 ALTERNATIVE 2

4.9.2.1 Project Are

Wells Dam

Within the Wells Dam area, Alternative 2 would assist the passage of adult fish through the maintenance of adult fishways and bypass systems, improved ladder operations, computer modeling to assist in identifying delay problems, and radio-telemetry to evaluate adult passage and survival. Measures to improve juvenile passage could include increased operation of the bypass system, increased spill, implementing a predator control program, and operating turbines at peak efficiency ratings.

The Wells Dam was constructed in the 1960s and does not appear to possess the exceptional significance necessary for properties less than 50-years old to be listed in the National Register. Therefore, the previously-described modifications to the dam would not impact a historic structure. In addition to modifications to the dam, Alternative 2 includes the implementation of management procedures, such as developing solutions to improve fish passage and operating the surface bypass system 24 hours per day to encourage migration of spring-run chinook salmon and steelhead. These actions would not involve noticeable fluctuations in water levels or ground disturbance that would impact cultural resources.

Prior to the inundation of the Wells reservoir in the 1960s, archaeologist G.F. Grabert identified numerous prehistoric sites along the historic shoreline of the Columbia River. Grabert also identified and excavated the archaeological remains of Fort Okanogan, the American Pacific Fur Company fort established in 1811 at the confluence of the Columbia and Okanogan rivers (Grabert 1968b). A subsequent study of the Wells reservoir area reported on 23 prehistoric archaeological sites, some of which had been previously identified (Chatters 1986).

Under Alternative 2, the NMFS has the authority to request any protection measures that would assist in the survival of endangered salmon and steelhead species, including the potential drawing down of reservoir waters to alter river flow. The fluctuation in water levels caused by drawing down the reservoir could impact sites along the shoreline and others that are currently inundated by the reservoir. Alternating wet and dry conditions could cause the deterioration of organic material found in these archaeological sites. Wave action and fluctuations in water levels may also cause erosion to archaeological sites, and artifact collectors could be attracted to exposed sites. In the event that the NMFS requires drawing down the reservoir, actions to protect cultural resources would be included in the operational constraints of the project.

Rocky Reach Dam

Under Alternative 2, the on-site protection measures for adult and juvenile passage in the Rocky Reach Dam area would be similar to those listed for the Wells Dam. The program for juvenile passage, however, would also include the construction of a permanent bypass system, a spill plan, replacement of old turbine runners, and radio-tracking for predator control.

The Rocky Reach Dam, constructed in the 1960s, does not appear to possess the exceptional significance necessary for properties less than 50 years old to be listed in the National Register. Therefore, the previously-described modifications to various components of the dam would not impact a historic structure.

In addition to modifying components of the Rocky Reach Dam, Alternative 2 involves the introduction of new management measures such as developing corrective actions for adult fish passage, if necessary and utilizing a 24-hour per day spill plan to encourage juvenile passage. Such management actions would not create noticeable fluctuations in water levels or ground disturbances that would impact archaeological sites, buildings, structures, or traditional cultural properties eligible for listing in the National Register.

Prior to the inundation of the Rocky Reach reservoir in the 1960s, Washington State University surveyed the flood zone and identified the remains of pithouses, resource procurement camps, and shell middens. A subsequent study of the reservoir conducted by Washington State University in 1983, located similar site types. Neither study identified prehistoric village sites in the area. The later study concluded that the area's apparent absence of village sites could be a result of the local topography, which lacked an easily accessible fishery. Although it is doubtful that undiscovered prehistoric village sites are located in this area, it is possible that additional small camps and resource procurement sites are located within the Rocky Reach project area. The historic period activities that occurred in this area are similar to those listed for the Rock Island Dam area. Historic period archaeological sites are also located in this area.

In the event that NMFS requires drawing down the Rocky Reach reservoir for the protection of the endangered species, impacts could occur to prehistoric and historic archaeological sites. Impacts to the Rocky Reach project area would be similar to those listed for the Rock Island project area. However, actions to protect cultural resources would be included in the operational constraints of the project.

Rock Island Dam

Alternative 2 would improve adult and juvenile fish passage in the Rock Island Dam project area by using the same measures listed for Rocky Reach

Dam, along with improved fishway efficiency created by maximizing the number of adult migrants that enter the facilities. Juvenile passage would also be encouraged, controlling total dissolved gas.

Constructed in 1933, the Rock Island Dam was the first hydroelectric dam on the Columbia River. A 1988 National Register evaluation of the structure determined that modifications have rendered the dam ineligible for the National Register. The National Register form indicates that, "the components of the dam installed between 1930 (when actual work began at the site) and 1936 (when the center fishladder was added) have all been altered virtually beyond recognition, with the exception of the downstream wall and front façade of Powerhouse 1" (Holstine 1988). Because the dam is ineligible for the National Register, changes to dam features, such as ladder modifications, would not impact a historic resource.

In addition to minor modifications to components of the Rock Island Dam, Alternative 2 includes a new management program, such as modeling to correct delay problems and operating the spillway to facilitate the movement of different fish species. These measures would not result in noticeable changes in water levels or ground disturbances that could impact archaeological sites. Nor would such actions impact historic buildings and structures or traditional cultural properties.

Prehistoric and historic archaeological sites are commonly found near natural sources of water. As noted in Section 3.9, a comprehensive study of the Rock Island Dam reservoir identified prehistoric hunting, fishing, and village sites in the study area (Lothson 1982). Historic period activities, such as exploration, fur trapping, homesteading, ranching, and hydroelectric development may have also left historic archaeological sites in the project area. Therefore, additional undiscovered prehistoric and historic sites could be located within the project area.

If the status of endangered species requires the NMFS to drawdown the Columbia River, permanently inundated sites located within the reservoir could be exposed. In this instance, the Rock Island Dam project area has the potential of experiencing the same impacts to archaeological resources as the Wells Dam. However, actions to protect cultural resources would be included in the operational constraints of the project.

Associated Tributaries

Alternative 2 does not include tributary enhancement projects funded by the PUDs, Thus, there are no projected impacts to cultural resources under this alternative.

Columbia River System

Salmon and steelhead are an important cultural resource that have played a significant role in the survival, culture, subsistence, social status, and religion of Native Americans living in the vicinity of the Columbia River (Hanes 1995).

Alternative 2 would take steps to protect salmon and steelhead listed as endangered species. This currently means that measures would be taken to protect Upper Columbia River spring-run chinook salmon and steelhead, and Middle Columbia River steelhead. If additional species were listed, additional protection measures would be developed for those stocks as well. The range of protection measures that the NMFS would implement could change overtime depending on the condition of the endangered species. Such steps are designed to benefit tribal cultural resources by working toward the continued survival of salmon.

Under Alternative 2, hatchery funding would continue to all existing fish hatcheries. Continued funding of these facilities is planned to be similar to existing conditions, although the number of hatchery fish available in the middle and lower Columbia River could be altered, based on new or recent research and direction by the NMFS. However, these decisions would be independent of project operations.

4.9.3 ALTERNATIVE 3

4.9.3.1 Project Area

Wells Dam

Under Alternative 3, the applicant would continue existing operations of the Wells Dam and work with fishery agencies and Tribes to optimize fish passage conditions. This would involve refining operating criteria for adult fishladders and developing minor changes to improve fishladder efficiency.

Because the Wells Dam does not appear historically significant, potential modifications to the dam (such as altering fishladders) would not impact a historic resource. As noted in Section 3.9, the Wells Dam includes numerous archaeological sites (Chatters 1986; Grabert 1968a). This alternative would not include ground disturbance or the fluctuation of water levels that could impact archaeological sites.

Rocky Reach Dam

Alternative 3 would require the installation of a turbine bypass system and replacement of turbine runners. This alternative would also involve operational modifications to the Rocky Reach Dam resulting in a spill program that facilitates fish migration, the evaluation of spill efficiency and total dissolved gas abatement options, the implementation of actions to minimize reservoir fluctuations, the maintenance of total dissolved gas levels at or below legal maximums (except during flood conditions), the enhancement of predator control measures, and the monitoring of mitigation measures on-site.

Because the Rocky Reach Dam does not appear historically significant, modifications to the dam such as the addition of a turbine bypass system and turbine runners, would not impact a historic property. As noted in Section 3.9, prehistoric and historic archaeological sites are located within the Rocky Reach Dam project area, primarily in the vicinity of the reservoir. None of the previously described actions associated with Alternative 3 would result in ground disturbance or increased fluctuations of water levels. This alternative therefore, would not impact resources eligible for listing in the National Register.

Rock Island Dam

Alternative 3 would involve installing a turbine bypass system, spill gate modifications, and possibly adding sluiceways and replacing turbine runners to improve juvenile anadromous salmonids at Rock Island Dam. This alternative would also include the following operational modifications to improve fish conditions: (1) limiting the use of turbines in Powerhouse 1, (2) minimizing reservoir level fluctuations, (3) maintaining total dissolved gas levels at or below legal maximums except under flood conditions, (4)enhancing predator control measures, and (5) performing studies to properly monitor mitigation measures used to improve fish conditions.

Because alterations to the dam have rendered it ineligible for the National Register, the addition of a turbine bypass system and other such modifications to the dam would not impact a historic resource. As noted in Section 3.9, previous archaeological surveys have identified prehistoric and historic archaeological sites located within the Rock Island Dam project area. Because the operational modifications associated with Alternative 3 would not result in ground disturbance or increased fluctuation of reservoir water levels, impacts would not occur to cultural resources eligible for listing in the National Register.

Associated Tributaries

Alternative 3 would involve habitat enhancement of the tributaries leading into the Wells, Rocky Reach, and Rock Island reservoirs. The primary tributaries affected by this action include the Wenatchee, Entiat, Methow, and Okanogan rivers. Specific impacts to resources located within the different tributaries have been listed below. Rather than detailing all habitat restoration measures for each area, this section identifies specific measures that could potentially impact historic resources.

National Register-eligible archaeological sites, historic structures and traditional cultural properties could experience impacts due to proposed tributary enhancements. As described in Section 3.9, prehistoric use of the tributary areas could have resulted in the development of domestic archaeological sites as well as resource processing stations for fish, mammals, birds, and plants. Archeological sites could also include campsites, burials, isolated finds, fire hearths, petroglyphs, and trails. Historic period remains within the tributary areas may be associated with fur trading, mining, logging, settlement, and farming. Historic period properties could consist of archaeological sites and structures such as irrigation canals, culverts, and old logging dams. Cultural resources within the tributary areas could also include plants important for Native American subsistence, spiritual, and medicinal purposes and traditional cultural properties identified by Tribes (Hanes 1995).

Wenatchee Watershed

The habitat restoration measures proposed for the Wenatchee watershed would improve the stream channel and floodplain conditions. Restoration measures may involve restoring floodplain function with the addition of vegetation along the river, altering diversion points to increase instream flows, reestablishing fish passage to wetlands currently cut off by Highway 2, developing riparian habitats in rights-of-ways along highways, modifying diversion dams to encourage anadromous fish passage to upper Icicle Creek, altering specific culverts to enhance the passage of anadromous salmonids, and restoring the mouth of Deep Creek and portions of Icicle Creek. Most of these actions would involve ground disturbance through such activities as planting vegetation along riverbanks or reestablishing access to wetlands by digging channels. Impacts could occur to archaeological sites and traditional cultural properties located within the areas where restoration projects would be implemented. Historic structures, such as irrigation canals and culverts, could also undergo impacts due to the tributary habitat restoration program in the Wenatchee watershed.

Entiat Watershed

Within the Entiat watershed, proposed restoration measures focus on enhancing the stream channel and floodplain to encourage fish development. Restoration would include improving fish habitat with the addition of boulders and wood debris to increase the number of pools in the river, revegetation along the lower reach of the Entiat River, and potential changes in the levels of water used by local irrigators. Depositing boulders and wood debris in the river is likely to disturb soils adjacent to the river with the use of heavy equipment along the riverbank. Other restoration measures, such as revegetation, would disturb soils and potentially impact archaeological resources or traditional cultural properties located within the study area. Historic structures, including irrigation canals and culverts, could also undergo impacts due to this action. Fluctuating water levels caused by changing water use by irrigators could expose archaeological sites and lead to site erosion and unauthorized artifact collection.

Methow Watershed

The proposed Methow watershed restoration plan includes implementing the Methow Valley Irrigation District renovation, restoring the side channel reaches of the watershed, restoring riparian habitat on lower Gold Creek, and providing passage at the State Route 153 culvert on Beaver Creek. If these actions are funded through the Plan Species Account, effects could include ground disturbances that could impact archaeological sites, traditional cultural properties, and historic structures.

Okanogan Watershed

In the Okanogan watershed, proposed habitat restoration measures focus on improving stream channel and floodplain conditions along the mainstem of the Okanogan River, restoring anadromous salmonid passage in Salmon and Omak creeks, revegetating and stabilizing portions of the Okanogan River bank, revegetating denuded portions of the lower Similkameen River, revegetating the middle Similkameen River if fish passage is restored in this river, revegetating and stabilizing portions of the erosive banks on the Okanogan between Bonapart and Omak creeks, and adding rock structures at selected locations in the watershed to enhance spawning habitat. Each of these actions has the potential of creating ground disturbances that would impact archaeological resources, traditional cultural properties, and historic properties.

Columbia River System

Salmon and steelhead are an important cultural resource that have played a significant role in the survival, culture, subsistence, social status, and religion of Native Americans living in the vicinity of the Columbia River (Hanes 1995).

Alternative 3 goes beyond the current requirements of the NMFS to take into consideration species that may be endangered in the future and protective measures that could contribute to the health of endangered species. Consequently, Alternative 3 would provide for the protection of the endangered Upper Columbia River spring-run chinook salmon and steelhead, as well as summer- and fall-run chinook, sockeye, and coho salmon. It also includes habitat enhancement of the tributaries leading into the Wells, Rocky Reach, and Rock Island reservoirs. The management approach stipulated in Alternative 3 would be effective for a fixed 50 years. Initially, such measures could be beneficial to cultural resources by encouraging the survival of salmon. However, if the health of endangered species declines significantly and more drastic protection measures became necessary, this plan only provides opportunity for new preservation methods to be used when existing measures are determined inadequate in meeting the HCP performance standards.

Native and hatchery-raised salmon and steelhead are an important cultural resource for Native American Tribes. If under Alternative 3, the Wells dams exceeds its projected survival rates for salmon, hatchery funding may be decreased at the Cassimer Bar and Methow hatcheries. Decreased funding to these facilities would limit the number of hatchery salmon and steelhead available for harvesting in the middle and lower portions of the Columbia River. This reduction in harvestable fish would result in an adverse impact to the traditional cultural resources of salmon.

4.9.4 MITIGATION

Numerous archaeological sites have been identified within the Wells, Rocky Reach, and Rock Island dam study areas. To assist in the management of these resources, the Chelan and Douglas County PUDs (in collaboration with the Washington Office of Archaeology and Historic Preservation) have developed strategies for managing cultural resources located within the Plan area. In 1988, the Chelan County PUD created a cultural resource management plan for the Rock Island Dam reservoir area (Galm and Masten 1988) and is currently in the process of establishing a cultural resource management plan for the Rocky Reach Dam reservoir area. The Douglas County PUD developed a Memorandum of Agreement to address the management of cultural resources within the Wells Dam project area. These documents are useful tools that aid in the management of cultural resource through providing guidelines for the identification, evaluation, and treatment of cultural resources.

As planned, all alternatives involve minor modifications to the Wells, Rocky Reach, and Rock Island dams, none of which appear eligible for listing in the National Register. This includes minor operational modifications that would not result in ground disturbance or fluctuating water levels. Therefore, it is unlikely that alternatives would impact resources eligible for the National Register.

Alternative 3 includes tributary habitat enhancement activities funded by the PUDs. As noted previously, habitat enhancement could include disturbances to shoreline areas where prehistoric and historic archaeological sites are commonly found. To limit impacts to archaeological sites, an archaeological survey should be conducted prior to the implementation of a habitat enhancement project. To assist in planning the survey and evaluating archaeological sites and historic properties, the groups responsible for implementing these projects should contact the Washington State Archaeologist and the affected Indian Tribes. A Washington State archaeological inventory form should be prepared for each site identified during the survey and submitted to the Office of Archaeology and Historic Preservation for a formal determination of National Register eligibility. In consultation with the State Archaeologist and the affected Indian Tribes, the implementation entity should assess the impact any project would have on any sites eligible for the National Register.

Mitigation measures should be developed for each National Register-eligible property that would be affected by the proposed tributary enhancement project. Mitigation measures could include excavation of archeological sites or stabilizing sites by covering them with fill. Historic properties could be documented to the standards of the National Park Service's Historic American Building Survey/Historic American Engineering Record. The tributary enhancement revegetation and floodplain development could result in exposed archaeological sites, As mentioned previously, increased artifact collection can occur when sites are exposed. To limit collection, a program should be developed to monitor exposed archaeological sites.

4.10 RELATIONSHIP TO LAWS AND POLICIES

This section addresses the State and Federal statutes, implementing regulations and executive orders that potentially apply to the alternatives considered in this EIS. It also considers the relationship of alternatives with State laws, tribal treaties and settlements, and U.S. treaties. The environmental impacts analysis discussed in this section provides the primary basis for the conclusions on compliance with environmental laws.

4.10.1 NATIONAL ENVIRONMENTAL POLICY ACT

This EIS was prepared pursuant to regulations implementing the NEPA (42 USC 4321), and in compliance with Federal regulations for preparing an EIS (40 CFR 1502). This EIS considers three alternatives, provides all required discussions and analysis, and has included public meetings, public scoping, coordination and opportunities for comment. Section 1.5 provides more detail on regulatory requirements and processes.

4.10.2 FEDERAL POWER ACT

The Federal Power Act provides FERC with the exclusive authority to license non-Federal water power projects on navigable waterways and Federal lands. For each project, the commission must decide: (1) whether to issue the license to an applicant, and (2) the conditions that should be placed on the license to protect or enhance existing environmental resources.

The FERC must consider the project's consistency with Federal or State comprehensive plans for improving, developing, or conserving the waterway. The Commission must weigh competing interests, including both power and non-power uses, to ensure a proper balance. As part of its licensing responsibilities, FERC must monitor the licensed projects to ensure compliance with regulations and terms and conditions with the license, including compliance with the Endangered Species Act and the Clean Water Act.

4.10.3 FISH AND WILDLIFE COORDINATION ACT

The Fish and Wildlife Coordination Act requires consultations with the USFWS when any water body is impounded, diverted, controlled or modified for any purpose by any agency under a Federal permit or license. The purpose of this Act is to ensure that potential impacts to fish and wildlife are identified and mitigated. Compliance with the Fish and Wildlife Coordination Act occurs through this EIS, through project licensing, and through the Endangered Species Act compliance activities incorporated in Alternatives 2 and 3.

4.10.4 FISHERY CONSERVATION AND MANAGEMENT ACT OF 1976

Also known as the Magnuson Act, the Act establishes a 200-mile fishery conservation zone and regional fishery management councils. The zone was amended to be the Exclusive Economic Zone, and its inner boundary includes the ocean shorelines of the coastal States, where Columbia River salmon and steelhead are found. The potential effects to fisheries in this zoning include an overall increase in salmonid populations if an alternative is successful in increasing salmonid survival through the three dams.

4.10.5 CLEAN WATER ACT

The Clean Water Act of 1977 (33 USC 26) was designed to restore and protect the chemical, physical and biological integrity of U.S. waters. The USEPA is responsible for enforcing the Act, but has delegated enforcement authority to the WDOE. Sections 3.3 and 4.3 discuss water quality issues related to the alternatives in this EIS.

4.10.6 WETLANDS PROTECTION

Executive Order 11990 directs Federal agencies to minimize the destruction, loss or degradation of wetlands. All waters of the U.S., including wetlands, fall under the Clean Water Act, and the U.S. Army Corps of Engineers is responsible for wetlands protection. Wetlands issues related to the alternatives are discussed in Section 4.4.

4.10.7 INDIAN TRUST ASSETS

The United States Government's trust responsibility for Indian resources requires Federal agencies to take measures to protect and maintain trust resources. The trust responsibilities include legal interests and rights, including lands and resource use, such as tribal rights to fisheries of Columbia basin salmon and steelhead species.

Secretarial Order #3206, developed jointly by the Secretaries of Commerce and the Interior for NMFS and USFWS, provides guidelines for coordinating Endangered Species Act compliance and tribal trust responsibilities. The Colville, Umatilla and Yakama Tribes hold rights to the affected fisheries. They have participated in the development of the HCP agreements, and they will be involved in implementation of the HCPs as members of the Coordinating Committee if they sign and become parties to the HCPs. NMFS has also provided additional opportunities for comments and coordination through the development of this EIS. Continued coordination and cooperation between Native Americans, the NMFS, and the PUDs is planned when the Tribes sign the HCPs.

The most significant issue that concerns the Tribes is whether NMFS can and should "guarantee" the HCPs goal of no net impact. The goal includes a 7 percent hatchery production level to compensate for unavoidable project mortality, which is similar to existing hatchery production under the FERC Settlement Agreements. Meeting the 7 percent annual goal would guarantee a hatchery production that supports current tribal salmon harvests and ensures the Tribes that hatchery production would not decline. However, if NMFS determines at a future date that this level of hatchery production hinders propagation and survival of wild fish, it may be necessary to reduce the number of hatchery fish produced. This would then affect whether the 9 percent no net impact would continue over the 50-year HCP terms. The Tribes believe that the hatchery fish represent Indian Trust Assets. The settlement agreement compensation levels for hatchery fish were for loss of salmon abundance and habitat caused by original dam construction.

4.10.8 ENVIRONMENTAL JUSTICE

Executive Order No. 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations, requires that Federal agencies avoid unequal distributions of adverse impacts to minority and low income populations. None of the alternatives in this EIS involve significant adverse impacts to transportation, land use, socioeconomic or recreation conditions in the project area (except under the remote possibility of drawdown), and thus the requirements of the Order do not apply. If drawdown is an option over the next 50 years under Alternative 2, an extensive analysis of its impacts to the communities dependent on the hydroelectric projects would be conducted prior to implementation.

4.10.9 STATE, AREA-WIDE AND LOCAL PLAN AND PROGRAM CONSISTENCY

Executive Order No. 12372 instructs agencies to consider the consistency of a proposed action with approved State and local plans and laws. This EIS analysis discusses land use plans in Section 4.6; fisheries plans in Section 4.2 recreation in Section 4.8, and cultural resources in Section 4.9. However, given the size of the project area and the limited direct impacts that were identified as a result of the proposed action, a detailed review of other land owner's plans, water rights agreements, and watershed plans was not determined applicable. To achieve the same goals, this EIS was prepared with input from cooperating and responsible agencies, and the EIS will be circulated with appropriate State and local entities to satisfy review and consultation requirements.

4.10.10 FLOODPLAIN MANAGEMENT

Executive Order 11988 requires Federal agencies to evaluate actions they might take in a floodplain and ensure that the actions consider flood hazards, floodplain management and alternatives to avoid or minimize potential harm. Section 4.3 of the EIS includes discussions of water quantity effects of the alternatives. However, as the hydroelectric projects are run-of-river facilities not designed for storage or flood control purposes and the tributary actions would not involve plans to change the overall floodplain in the project area, except in the unlikely event of drawdown under Alternative 2. However, if drawdown is considered, a separate NEPA analysis would be conducted.

Tributary enhancement could involve changes in shoreline areas that would affect floodplains under all alternatives. Effects from flooding to land use are discussed in Section 4.6.

4.10.11 PACIFIC NORTHWEST ELECTRIC POWER PLANNING AND CONSERVATION ACT

Congress passed the Northwest Power Act in 1980 (16 USC 829d), creating the Northwest Power Planning Council. The council's membership and programs are summarized in Section 1.5.2.5. The council is not a Federal agency and does not have regulatory control of Columbia River resources. Most of the programs under the council are funded by BPA revenues and do not directly involve the PUDs. Still, there are some programs that are related to the proposed action, and NMFS must ensure that salmon and steelhead species conservation and recovery programs are consistent.

- The Council's Multi-Species Framework Project is bringing State, Federal and tribal governments together with stakeholders to review alternative approaches to fish and wildlife policy from a basin-wide perspective; the project emphasizes restoring environmental conditions for multiple species through changes in river management and hydropower project operating policies. This EIS considers effects to the ecosystem in Sections 4.2 through 4.5, and the HCP also includes takes an ecosystem approach that is consistent with the Council's multi-species strategy.

- The Fish Passage Center is part of the Council's Fish and Wildlife Program, and is charged with implementing flow for fish migration at Federal and non-Federal Columbia and Snake River hydroelectric projects. The alternatives considered in this EIS would involve continued coordination of their flow programs with the Center.

4.10.12 HERITAGE RESOURCE PROTECTION

A number of Federal laws protect the nation's historical, cultural and prehistoric resources as described below.

4.10.12.1 National Historic Preservation Act

Section 106 of the National Historic Preservation Act requires that Federal agencies evaluate the effects of Federal actions on historical, archeological and cultural resources, and afford the Advisory Council on Historic Preservation an opportunity to comment on the proposed action. Compliance with the National Historic Preservation Act for all of the alternatives is discussed in Section 4.9.

4.10.12.2 Archeological Resources Protection Act and Native American Graves Protection and Repatriation Act

Section 4.9 of the EIS discusses the potential for impacts to resources protected by these acts, which protect the treatment of known and unknown archeological sites, Native American human remains, and cultural items. In the mainstem area of the project, all of the alternatives have the same potential for continued erosion, potential exposure and damage of cultural sites in the reservoir areas. Although the upstream tributary projects involve no known cultural or archeological resource sites, appropriate construction, monitoring and surveillance programs would be necessary to prevent or minimize impacts to resources as individual tributary projects are developed.

4.10.13 WATER RIGHTS

The western states obtained ownership of streams and control of the water within each State upon admission to the union. State laws regulate the acquisition and use of water and limit its use to beneficial purposes as defined by the State. Washington State law governs individual water rights, which are granted in terms of the type of water use, the period of use, the source of water, the location of the point of diversion and place of use, and the rate and total volume of water that may be diverted. The WDOE is responsible for the State's water permitting program, and the mainstem Columbia River and each of the tributaries have highly complex water rights characteristics. Although Alternative 3 proposes tributary enhancement programs in areas where existing water withdrawals have historically affected habitat, the HCP would not involve major impacts to existing water rights agreements. None of the alternatives would affect water rights on the mainstem Columbia River.

4.10.14 RECREATION RESOURCES

A number of acts require that Federal agencies should consider and minimize the recreational and scenic effects of actions involving water resource projects. The primary acts affecting the Columbia basin are described below.

4.10.14.1 Wild and Scenic Rivers Act

The Wild and Scenic Rivers Act of 1968 designates qualifying free-flowing river segments as wild, scenic, or recreational. The Act does not currently apply to rivers in the EIS study area. However, designation for the Hanford Reach, a 50-mile free flowing segment of the Columbia River below

Priest Rapids dam, has been considered repeatedly over the past several years, both in the U.S. Congress and in the Washington State Legislature. Still, none of the alternatives would affect a potential designation because they would not have a significant adverse impact to water resources or fisheries in the reach. In addition, the plan area itself would not qualify for designation because of the existing reservoir impoundments.

4.10.14.2 Wilderness Act

The Wilderness Act of 1964 (16 USCA 1131) established the National Wilderness Preservation System. Areas designed under the act and subsequent legislation are to be administrated for the use and enjoyment of the public, leaving them unimpaired as wilderness. Development activities are generally prohibited, and Federal agencies must consider whether their actions would impact wilderness values. Although there are wilderness areas in the basin, none are located in the Plan activity areas.

4.10.14.3 Water Resources Development Act

Congress authorizes and amends the Water Resources Development Act biennially, and new legislation is pending this year. However, the Act generally requires public and interagency participation in changes to reservoir operation criteria. The FERC licensing process (and the existing license conditions for the projects) ensures compliance with the Act, and neither alternative considered in this EIS would involve substantial changes to reservoir operations, excepting the possibility of drawdown as described under Alternative 2. If drawdown is considered, it would be evaluated under a separate NEPA analysis in the future.

4.10.15 FEDERAL WATER PROJECT RECREATION ACT

This act (16 USCA 4612) requires full consideration of a water resources project for outdoor recreation and fish and wildlife enhancement. Again, the FERC licensing process and the existing license requirements generally satisfy the requirements of the Act. This EIS examines the additional fisheries requirements that may be needed for compliance with the Endangered Species Act.

4.10.16 POLLUTION CONTROL

Federal agencies are required to carry out other Federal environmental laws governing effects to people and the environment. However, the alternatives discussed in this EIS do not involve specific actions that involve pollution control laws, and instead involve broader decisions for Endangered Species Act compliance and resource protection. To the extent that subsequent projects, including tributary enhancement projects, would be implemented, appropriate documentation would be developed and any applicable pollution control permits would be obtained.

4.10.17 TREATY OBLIGATIONS

4.10.17.1 Columbia River Treaty of 1961

This power planning treaty between the United States and Canada established four large reservoir dams in the upper Columbia reaches, and defined the cooperative use of the dams for water supply, flood control and power generation. Through the related agreement described below, the PUDs are responsible for providing a portion of the power benefits guaranteed to Canada by the treaty, and this treaty will not expire until 2024. No alternative will affect this treaty.

4.10.17.2 Pacific Salmon Treaty

The 1985 Canada-United State Pacific Salmon Treaty was negotiated to ensure conservation and an equitable harvest of salmon stocks. The countries and affected Tribes meet annually to negotiate future fishing regime, primarily through the Pacific Salmon Commission. The primary goals of the treaty are to prevent overfishing and to provide equitable benefits to the parties, based on the production of salmon and steelhead from their own rivers. For this EIS, no alternative's approach will affect ocean impacts to the salmon and steelhead species, which involve both the amount of harvest and conditions in the ocean ecosystem. However, the alternatives in the EIS would affect the number of fish that migrate to the ocean. Therefore, if an alternative is found to meet the NMFS jeopardy standards (no adverse effects for the survival of the species), the alternative would be considered an enhancement to the United States' ability to meet its treaty obligations.

4.11 UNAVOIDABLE ADVERSE EFFECTS

Any of the alternatives considered in this Draft EIS could result in adverse environmental effects, including those that cannot be avoided or completely mitigated. For each resource area that may be impacted, Chapter 4 describes the anticipated effects and describes measures that can be taken to avoid or mitigate the impact, and to lessen the significance of the impacts.

Again, it is important to distinguish the ongoing and historic adverse effects of the hydroelectric projects, as opposed to the probable effects of the alternatives. All of the alternatives involve approaches to minimize harm to fish species, to compensate for fish losses, and to enhance the potential for species survival. All alternatives will result in mortality to Federally protected salmon and steelhead. Alternative 3 proposes mitigation and enhancements to result in no net impact, the equivalent of 100 percent survival for all Plan species.

In large part, specific details about individual actions that would occur under the action alternatives are still to be determined, based on additional technical studies. However, the two action alternatives involve a long-term monitoring program that is designed to document the level of effects and allow the PUDs to respond with necessary actions to minimize or mitigate for them.

4.12 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

None of the alternatives involve an irreversible commitment to use, modify or affect non-renewable resources such as cultural resources or minerals. However, the alternatives do involve protected salmon and steelhead species, which historically have been considered a renewable resource but are now in threat of extinction. As salmon and steelhead recovery may occur over a long but still unknown period of time, the 50-year term of Alternative 3 does involve a commitment of resources to protect salmon and steelhead. Incidental take of the protected species will be allowed as long as the HCPs are implemented as agreed. With the proposed action, an irretrievable commitment could therefore occur if the species continue to deteriorate to the point that renewal can only occur over a longer period of time and at great expense. However, the analysis conducted for this EIS did not reveal that the two action alternatives designed to protect endangered or threatened fish involved substantial differences in their effect on the protected species. Alternative 1 can only protect endangered and threatened fish through ongoing license agreements. None of the other activities related to the HCPs or the proposed action is considered likely to result in an irreversible and irretrievable commitment of resources.

4.13 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

This discussion considers some of the differences between short-term needs and uses of the environment and resources, as opposed to maintaining and enhancing long-term productivity. In most resource areas, the two action alternatives would not have substantially different results. Alternative 1 results in a high likelihood of extinction for listed species. Therefore it is not a viable long-term alternative. For the action alternatives, there would also not be a substantial difference between short-term and long-term productivity effects. These alternatives include similar actions to reduce mortality to salmon and steelhead species and improve the potential for their survival.

Based on existing information, the action alternatives appear to have a similar potential to increase salmon and steelhead populations, support increased productivity, and potentially contribute to the long-term recovery of the protected species. Similar improvements and enhancements to the projects are proposed for the three alternatives, although only the HCPs include a program for enhancing tributaries.

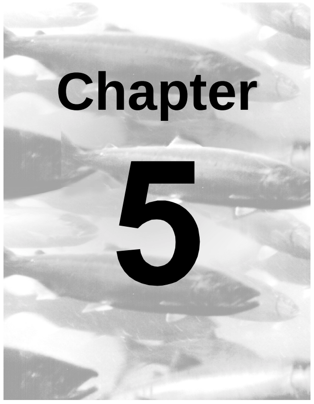
The primary consideration would be between the competing short-term and long-term needs for ensuring salmon and steelhead survival and recovery and providing power. The PUD proposed action is for a 50-year permit to operate the projects under the HCPs, allowing the PUDs to take a long-term approach for complying with the Endangered Species Act and to plan and market their power production programs. This would improve the PUDs abilities to obtain long-term financing, develop long-term power sales agreements, and maintain the low utility rates it now provides its customers. At the same time, the HCP defines the level of mitigation and compensation that would be required over the 50-year period in terms of funding the HCPs and modifying operations at the plant.

While individual actions can be modified as needed, the level of funding for hatchery and tributary compensations and the performance goals cannot be changed as long as the HCPs are being implemented as agreed. While this provides a substantial amount of planning and financial certainty for the PUDs and its customers, there is the risk of uncertainty on the long-term effects to the species, given the limits of existing information. The action alternatives use an adaptive management approach that is designed to reduce this risk of the unknown by allowing the PUDs, the resource agencies, and others to adjust their programs based on new information. In addition, Alternative 3 would help to increase salmonid habitat in the tributaries compared to existing conditions.

Alternative 2, however, could require modifications to both the project features and could require habitat improvements as necessary to aid in the recovery of listed species at any time as long as the species remain Federally protected. It also does not provide a maximum amount of funding or operational changes that could ultimately be required. At any time, new information about protected species in the Mid-Columbia River basin could re-open discussions about the effects of the projects and the actions that may be required. This would provide the maximum amount of flexibility for managing overall recovery of Columbia River species, but it provides a substantially lower level of planning and operating certainty for the PUDs. While it is impossible to predict the full range of actions that could be required in the future, they most likely would involve increased funding from the PUDs for species recovery, and changes in hydropower operations, some of which could substantially reduce power production capabilities.

Alternative 1 mitigates for some of the impacts caused by project operations through license stipulations, amendments, and settlement agreements. Alternative 2 provides additional protection only for species once they are listed as threatened or endangered. Alternative 3 is designed to protect those anadromous salmonids not yet listed, and may help to prevent their listing in the future.

Alternative 3 will also provide long-term habitat improvements to the tributaries over the next 50 years through annual funding to the Plan Species Account. The funds would be used by the Tributary Committee to restore and enhance salmonid breeding habitat.



Chapter 5

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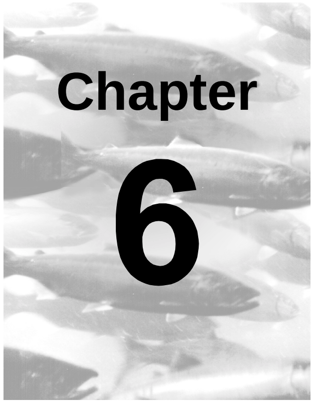


Chapter 6

Glossary

Chapter

6 GLOSSARY

303(d) list – A list of water bodies that the WDOE has identified as having impaired water quality based on evidence that specific water quality standards have not been met. Section 303(d) of the Federal Clean Water Act requires that states prepare and periodically update these lists and develop controls to bring the water bodies into compliance with standards and protect beneficial water uses (e.g., water supply, cold water fisheries, etc.). Hundreds of creeks and river segments in Washington are currently on the 303(d) list.

Adaptive Management – The process of monitoring the implementation of conservation measures, then adjusting future conservation measures according to what was learned. Adaptive management can also include testing of alternative conservation measures, monitoring the results, and then choosing the most effective and efficient measures for long-term implementation.

Alevin – The life stage of salmonids between hatching and active feeding when the yolk sac is still present, generally equivalent to sac fry or larval stage.

Anadromous – Describes the life-history characteristic of a fish species that reproduces in freshwater, migrates to the ocean for some portion of its rearing stage, and returns to freshwater as an adult.

Aquatic Macrophytes – Plants that occur entirely immersed within or under water.

Artificial Supplementation – Hatchery programs.

Basalt – A fine-grained, igneous rock dominated by dark-colored minerals. Cliffs along the Columbia River Valley are typically formed in basalt.

Base Flow – The normal low flow that occurs seasonally in a river or creek. During a period of run-off from rain or snowmelt, streams rise above base flow levels and then recede to base flows sometime after the runoff event has passed. Base flows are sustained by groundwater discharges that may vary seasonally (e.g., higher base flow in the spring and lower in the summer).

Biological Assessment – A legally mandated requirement under the Endangered Species Act of 1968, to assess the affects of a Federal action on a Federally listed threatened or endangered species. A biological assessment report is prepared by the project proponent and provides existing and projected conditions that affect a threatened or endangered species and the proposed mitigation measures that minimize or avoid impacts to these species.

Biological Opinion – A legal opinion from the U.S. Fish and Wildlife Service or the NMFS as to the effects of a Federal action on a Federally listed threatened or endangered species. This biological opinion is a report that reviews and considers the adequacy of the biological assessment that is initially prepared by the project proponent. The biological opinion includes conservation measures recommended by the agency to protect the listed species.

Biological Productivity – Capacity of an ecological system to produce or support a particular poplation size of an animal (fish) or plant species.

Brood Stock – Group of fish that are used to provide eggs and sperm to produce a hatchery stock to supplement or replace reproduction in a natural environment.

Bypass System – Structure in a dam that provides a route for fish to move through or around the dam without going through the turbines.

Candidate Species – As defined by the NMFS – candidate species are wildlife, fish, and/or plants being considered for listing as endangered or threatened, but for which more information is needed before they can be proposed for listing.

Categorical Exclusion – Under NEPA regulations, a category of actions that does not individually or cumulatively have a significant effect on the human environment and have been found to have no such effect in procedures adopted by a Federal agency pursuant to NEPA. (40 CFR 1508.4)

Channel Structure – Channel structure is formed by river bed roughness elements like bars and bends, in channel logs or debris jams, bank vegetation, and large rocks. Channel structure is important for channel flow velocities, aquatic habitat, and can help to prevent channel erosion.

Character Defining Features – The components of an historic property that contribute to its historical significance.

Columbia Plateau – Relatively flat region of eastern Washington and Northern Oregon formed by vast accumulations of near horizontal flows of basalt lava.

Complete Application Package – Section 10 permit application package presented by the permit applicant to the Field Office or Regional Office for processing. It contains an application form, fee (if required), HCP, EA, or EIS. In order to begin processing, the package must be accompanied by a certification by the Field Office that it has reviewed the application documents and finds them to be statutorily complete.

Conservation Measures: actions that a non-Federal property owner voluntarily agrees to undertake when entering into a Habitat Conservation Agreement with assurances.

Conservation Plan Area – Lands and other areas encompassed by specific boundaries which are affected by the conservation plan and incidental take permit.

Covered Species – Species that have been adequately addressed in an HCP as though they were listed, and are therefore included on the permit or, alternatively, for which assurances are provided by the permittee that such species will be added to the permit if listed under certain circumstances. "Covered species" are also subject to the assurances of the "no surprise" policy. Also referred to as "Plan species".

Critical Habitat – Specific areas occupied by a species that contain physical and biological features essential to the conservation of the species, and which may require special management considerations for protection. These areas might provide space for individual or population growth, nutritional or physiological requirements, breeding and rearing habitat, shelter or cover for protection, or represent the historical or geographical distribution of the species.

Cultural Resource – nonrenewable evidence of human occupations or activity as seen in any district, site, building, structure, artifact, ruin, object, work of art, architecture, or natural feature associated with the cultural practices or beliefs of a living community.

Cumulative Impact or Effect – Under NEPA regulations, the incremental environmental impact or effect of the action together with the impacts of past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions (40 CFR 1508.7). Under Endangered Species Act Section 7 regulations, the effect of future state or private activities not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02).

Dam – A concrete structure impounding a river.

Delist – To remove from the Federal list of endangered and threatened species (50 CFR 17.11 and 17.12) because such species no longer meets any of the five listing factors provided under Section 4 (a)(1) of the Endangered Species Act and under which the species was originally listed (i.e., because the species has become extinct or is recovered).

Development or Land Use Area – Those portions of the conservation plan area that are proposed for development or land use or are anticipated to be developed or utilized.

Dissolved Oxygen – The amount of oxygen that is in solution. Compared to warm-water fish (e.g., large mouth bass or catfish), cold-water fish (e.g., salmon and trout) require relatively high levels of oxygen for respiration. Water quality standards for dissolved oxygen are minimum concentrations to protect cold-water fisheries.

Drawdown – The distance that the water surface of a reservoir is lowered from a given elevation as water is released from the reservoir. Also refers to the act of lowering reservoir levels.

Effect or Impact – Under NEPA regulations, a direct result of an action that occurs at the same time and place; or an indirect result of an action that occurs later in time or in a different place and is reasonably foreseeable; or the cumulative results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions (40 CFR 1508.8). Under Endangered Species Act Section 7 regulations, "effects of the action" means "direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline" (50 CFR 402.02).

Embankment – The earthen portion of a dam that is typically filled in after the concrete portion is built to form the reservoir.

Endangered Species – A species of plant, fish, or wildlife which is in danger of extinction throughout all or a significant portion of its range.

Endangered Species Act – The Endangered Species Act of 1973, 16 U.S.C. ss 1531 through 1543, as amended and its implementing regulations. Federal legislation which provides a means to ensure the continued existence of threatened or endangered species and the protection of critical habitat of such species.

Environmental Impact Statement – A detailed written statement required by Section 102 (2)(C) of NEPA containing, among other things, an analyses of environmental impacts of a proposed action and alternatives considered, adverse effects of the project that cannot be avoided, alternative courses of action, short-term uses of the environment versus the maintenance and enhancement of long-term productivity, and irreversible and irretrievable commitment of resources (40 CFR 1508.11 and 40 CFR 1502).

Evolutionarily Significant Unit – A reproductively isolated animal or fish population that represents an important component in the ecological/genetic diversity evolution of the species. The unit typically has a relatively confined historical or geographical distribution. To be considered an ESU, a population must satisfy two criteria: (1) It must be reproductively isolated from other population units of the same species, and (2) it must represent an important component in the evolutionary legacy of the biological species. The first criterion, reproductive isolation, need not be absolute but must have been strong enough to permit evolutionarily important differences to occur in different population units. The second criterion is met if the population contributes substantially to the ecological or genetic diversity of the species as a whole.

Fallback – Adult fish that successfully pass upstream of a dam, but are either swept or swim through the spillway, turbines, or navigation locks to below the dam.

FERC License – A Federal license for hydroelectric projects that includes requirements and restrictions about how the projects are maintained and operated. The PUD hydroelectric projects are licensed by the FERC, under the Federal Power Act.

Fishladders – A series of ascending pools constructed to enable salmon or other fish to swim upstream to pass a barrier.

Fish Passage Efficiency – The portion of all juvenile salmon and steelhead passing a facility that do not pass through the turbines.

Fish Passage Facilities – The features of a dam that enable fish to move around, through, or over a dam without harm. Facilities generally include an upstream fishladder and/or a downstream bypass system. A fishladder is a series of ascending pools constructed to enable salmon or other fish to swim upstream past the dam or barrier. A bypass system is a structure that provides a route for fish to move through or around the dam without going through turbine units that are the primary source of fish mortality in a dam.

Flow (or Discharge) – A measurable quantity of water passing through a dam or a reach of river over a given period of time. Flows for rivers in the United States are commonly reported in cfs.

Fluvial – Related to rivers, produced by river action like a fluvial plain or river bar.

Forebay – The portion of the reservoir at a hydroelectric plant which is immediately upstream of the generating station.

Formal Permit Application Consultation Phase – The phase of the Section 10 process that begins when the Regional Office receives a " complete application package" and ends when a decision on permit issuance is finalized.

Fry – Life stage of fish between the egg and fingerling stages. For salmon this typically refers to fish less then 50 millimeters long.

Gas Bubble Disease – Condition caused when dissolved gas in supersaturated water comes out of solution and equilibrates with atmospheric conditions, forming bubbles within the tissue of aquatic organisms. This condition can kill or harm fish.

Gas Supersaturation – Concentrations of dissolved gas in water that are above the saturation (100 percent capacity) level of the water.

Geomorphology – Branch of geology that deals with the form of the earth and earth surface and the changes that take place in river and hillside landforms.

Glacial – Related to or formed by a glacier. Extensive glaciers flowed into the Mid-Columbia River area greatly influencing the river and valley landforms and geologic deposits.

Gneiss – Coarse grained, metamorphic rock in which bands of differing mineral composition and texture appear.

Graben– An elongate, trench like structural form bounded by parallel faults, created when the block that forms the valley floor moved downward relative to the blocks that form the valley wall sides.

Habitat – The location where a particular taxon of plant or animal lives and its surroundings; the term includes the presence of a group of particular environmental conditions surrounding an organism including air, water, soil, mineral elements, moisture, temperature, and topography.

Habitat Conservation Plan (HCP) – Under Section 10 (a)(2)(A) of the Endangered Species Act, a planning document that is a mandatory component of an incidental take permit application. The HCP process is intended provide a comprehensive, long-term management plan to protect and facilitate the recovery of threatened and endangered species, and to provide a framework for "creative partnerships" between the public and private sectors in endangered species conservation (H.R. Rep. No. 97-835, 97th Congress, Second Session).

Habitat Improvement – Management of wildlife or fish habitat to increase its capability for supporting wildlife or fish.

Harass – Defined in regulations implementing the Endangered Species Act promulgated by the Department of the Interior as "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, and sheltering" (50 CFR17.3). NMFS has not defined "harass" by regulation.

Harm – Defined in regulations implementing the Endangered Species Act promulgated by the Department of the Interior as an act "which actually kills or injures" listed wildlife; harm may include "significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering" (50 CFR 17.3). NMFS has not defined "harm" by regulation.

Hatchery – A facility in which fish eggs are incubated and hatched and juvenile fish are reared for release to rivers or lakes.

HCP Development Phase – The period in the Section 10 process during which the applicant works with the USFWS or the NMFS Field Office to develop HCP and associated documents. This phase ends when the Field Office forwards a "complete application package" to the Regional Office.

Headwater Elevation – The average or maximum reservoir elevation at the project dam.

Historic Integrity – The extent to which a property has retained its original design and setting.

Historic Property – A property listed on the National Register of Historic Places.

Hydroelectric – Referring to the production of electric power through use of the gravitational force of falling water.

Hydrology – The science of dealing with the continuous cycle of evapotranspiration, precipitation, and run-off.

Implementing Agreement – An Agreement that legally binds the permittee to the requirements and responsibilities of a conservation plan and Section 10 permit. It may assign the responsibility for planning, approving, and implementing the mitigation measures under the HCP.

Incidental Take – Take of any Federally listed fish, wildlife or plant species that is incidental to, but not the purpose of, otherwise lawful activities. See definition for "take" [Endangered Species Act Section 10 (a)(1)(B)].

Incidental Take Permit – A permit that exempts a permittee from the take prohibition of Section 9 of the Endangered Species Act provided that a "conservation plan" has been developed that specifies the likely take and steps that the applicant will use to mitigate and minimize the take. An incidental take permit is issued by the USFWS or NMFS under Section 10 of the Endangered Species Act for non-Federal applicants.

Incidental Take Statement – An incidental take statement is issued under Section 7 of the Endangered Species Act for projects that involve a Federal action. The statement identifies the extent of the take that would occur as a result of the action, as well as reasonable and prudent measures to minimize the take.

Instream Flow – The amount of water in a river or creek required to sustain fisheries and water quality needs. Fisheries biologists and hydrologists have developed a model called the "instream flow incremental methodology", which is applied to streams to determine the flows needed for fish habitat.

Intake – The entrance to a conduit through a dam or water facility.

Juvenile – The early stage in the life cycle of anadromous fish when they migrate downstream.

Juvenile Bypass – Facility that is used to collect, divert or guide juvenile fish around a dam that provides a safer passage route than through the turbine units.

Kelts – Adult steelhead that have completed spawning and are returning to the ocean. Steelhead can spawn more than once in their lifetime.

Listed Species – Wildlife, fish, and/or plants that are identified as either threatened or endangered within a region, state, or nation. Federally-listed species are listed by the USFWS or NMFS and consequently receive statutory protection throughout areas where their populations are in decline under the Endangered Species Act.

Measures – Any action, structure, facility, or program (on-site or off-site) intended to improve the survival of Plan species.

Mid-Columbia River – That portion of the Columbia River that begins at its confluence with the Snake River up to the Chief Joseph dam.

Mitigation – Measures designed to couteract environmental impacts or make impacts less severe. These measures may include amending an impact by not taking a certain action or part of an action; minimizing an impact by repairing, rehabilitating, or restoring the affected environment; reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; or compensating for the impact by replacing or providing substitute resources or environment.

Monitoring – HCP monitoring consists of two types: (1) compliance monitoring where NMFS monitors the permittee's implementation of the requirements of the HCP, incidental take permit terms and conditions and implementation agreement, if applicable, and (2) effects and effectiveness monitoring where the permitee (or other designated entity) examines the impacts of the authorized incidental take (effects) and implementation of the operating conservation program to determine if the actions are producing the desired results (effectiveness).

National Environmental Policy Act (NEPA) – Federal legislation establishing national policy that environmental impacts will be evaluated as an integral part of any major Federal actions significantly affecting the quality of the human environment (42 U.S.C. 4321-4327).

National Register of Historic Places – The official federal list of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, engineering, and culture.

No Net Impact – An objective of the HCPs is to achieve 100 percent no net impact for each Plan species affected by the Wells, Rocky Reach, and Rock Island hydroelectric projects. The no net impact standard consists of two primary components: ninety-one percent project passage survival, achieved within the geographic area of the projects, and a nine percent compensation for unavoidable project mortality. The utilities would compensate for the 9 percent fish loss at the projects through a hatchery and tributary habitat fund. Hatcheries would compensate for 7 percent of fish mortality at the projects. Habitat improvements in the Mid-Columbia River tributaries would compensate for the remaining 2 percent mortality. This compensation for project mortality would result in a no net impact standard at the three projects.

No Surprises Policy – A policy of NMFS and USFWS providing regulation assurances for an HCP incidental take permit holder that no additional land use restrictions or financial compensation would be required with respect to species covered by the permit, even if unforeseen circumstances arise after the permit is issued that indicate additional mitigation is needed to protect the species.

Noxious Weeds – These weeds are non-native plants that have been introduced to Washington. Noxious weeds can be destructive and competitive with native plants, and difficult to control by cultural or chemical practices. These exotic species can reduce crop yields, replace native plant and animal habitat, affect land values and recreational opportunities, and infiltrate waterways.

Old-Growth Forest – A forest stand characterized by trees well past the age of maturity) dominant trees exceed 200 years of age). Stands exhibit declining growth rates and signs of decadence such as dead and dying trees, snags, and downed woody material.

Performance criteria – Standards used to determine the adequacy of the mitigation and conservation measures implemented to protect the species.

Permit – An incidental take permit issued to the District pursuant to Section 10 (a)(1)(B) of the Endangered Species Act to authorize any incidental take of listed species which may result from the District's otherwise lawful operation of the Project, conducted in accordance with this Agreement.

Permit species – For the purposes of this EIS, Permit species are all Plan species except coho salmon (*Oncorhynchus kisutch*). Permit Species do not include coho salmon since wild coho salmon are extirpated from the Mid-Columbia region and therefore not protected by the Endangered Species Act.

Physiographic Regions – Areas with similar landforms, geologic materials, soils, and climate.

PIT-Tag – A Passive Integrated Transponder tag (about the size of a grain of rice) transmits a digital code, unique to an individual fish when the tagged animal passes through a detection tunnel. The tag uses the power emitted by the detection system to transmit the signal, thus it has no batteries (making it functional for years). The tag is typically used on juvenile fish to assess passage survival, as well as survival at the adult stage.

Plan Species – For the purposes of this EIS, Plan species are spring, summer, and fall chinook salmon (*Oncorhynchus tshawytscha),* sockeye salmon (*O. nerka*), coho salmon (*O. kisutch*), and steelhead (*O. mykiss*).

Powerhouse – Section of a dam that contains the turbine units to generate electricity.

Priority Habitats (as designated by WDFW) – Priority habitats are those habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type or dominant plant species, a described successional stage, or a specific structural element.

Project – Refers to the Anadromous Fish Agreements and Habitat Conservation Plans Environmental Impact Statement for the Wells, Rocky Reach, and Rock Island hydroelectric projects.

Proposed Action – Under NEPA regulations, a plan that has a goal which contains sufficient details about the intended actions to be taken or that will result, to allow alternatives to be developed and its environmental impacts to be analyzed (40 CFR 1508.23).

Proposed Species – A species for which a proposed rule to add the species to the Federal list of threatened and endangered species has been published in the Federal Register.

Radio Telemetry – Methodology consisting of attaching or implanting a radio tag in a fish or animal to track its movements or to detect its presence in specific areas that are monitored with a radio receiver and antenna.

Record of Decision (ROD) – Under NEPA regulations, a concise public record of decision prepared by the Federal agency, pursuant to NEPA, that contains a statement of the decision, identification and discussion of all factors used by the agency in making its decision, identification of all alternatives considered, identification of the environmentally preferred alternative, a statement as to whether all practical means to avoid or minimize environmental harm from the alternative selected have been adopted (and if not, why they were not), and a summary of monitoring and enforcement measures where applicable for any mitigation (40 CFR 1505.2).

Redd – Depression in river or lake bed dug by fish for the deposition of eggs (spawning nests).

Reservoir – An artificially impounded body of water.

Resident – Describes the life-history characteristic of a fish species that spends its entire life in freshwater.

Riparian Vegetation – Riparian zones are broadly defined as those non-aquatic areas contiguous with waterbodies (wetlands, lakes, streams, and rivers) that are influenced by, and which influence, that water body. Often riparian zones exhibit higher plant and animal diversity and productivity than surrounding uplands, and are particularly important to fish and wildlife in arid regions. Riparian vegetation may or may not be distinct from the adjacent upland vegetation.

Riprap – Broken rock, cobbles, or boulders placed on the bank of a stream or river for protection against the erosive action of water.

River Terrace – Relatively flat areas formed by the rivers. Terraces near the rivers are active floodplains; higher terraces have been abandoned by river down-cutting and are no longer accessed by flood flows. Floodplain terraces are common locations for wetlands and side channels, and are important areas for storage of floodwaters, and aquatic and wildlife habitat.

Run-of-the-River Hydroelectric Project – The Wells, Rocky Reach, and Rock Island hydroelectric projects are run-of-the river projects, which means that they do not store substantial amounts of water in their reservoirs. Run-of-the-river hydroelectric projects produce electric power through use of the gravitational force of falling water, and consist of a powerhouse, spillway and embankments, as well as fish passage facilities.

Salmonids – Fish of the family Salmonidae, such as salmon, trout (including steelhead), char, and whitefish.

Schist – Medium or coarse grained, metamorphic rock dominated by subparallel orientation of platy mica minerals.

Scoping – The process of defining the scope of a study, primarily with respect to the issues, geographic area, and alternatives to be considered. The term is typically used in association with environmental documents prepared under NEPA.

Section 10 – The section of the Endangered Species Act dealing with exceptions to the prohibitions of Section 9 of the Endangered Species Act.

Section 10 (a)(1)(B) – That portion of Section 10 of the Endangered Species Act that allows for permits for incidental taking of threatened or endangered species.

Section 10 (a)(1)(A) – That portion of Section 10 of the Endangered Species Act that allows for permits for the taking of threatened or endangered species for scientific purposes or for purposes of enhancement of propagation or survival.

Section 106 of the Historic Preservation Act – A federal regulation that requires properties with federal involvement to take into consideration impacts to properties listed in or eligible for the National Register.

Section 4 (d) – Section of the Endangered Species Act that allows NMFS or USFWS to adopt whatever "protective regulations" it deems necessary for the "conservation" of a threatened species. This section does not apply to endangered species.

Section 7 – The section of the Endangered Species Act which describes the responsibilities of Federal agencies in conserving threatened and endangered species. Section 7 (a)(1) requires all Federal agencies "in consultation with and with the assistance of the Secretary [to] utilize their authorities in the furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species." Section 7 (a)(2) requires Federal agencies to "ensure that any action authorized, funded, or carried out by such agency…is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of…" designated critical habitat.

Section 9 – The section of the Endangered Species Act dealing with prohibited acts, including the "take" of any listed species without the specific authorization of the USFWS or the NMFS for species under the jurisdiction of each agency.

Sediment – Clay, silt, sand, gravel and cobbles that are deposited into layers by wind, ice, water, or gravity.

Set of Findings – Fish and Wildlife Service document (also used by NMFS) that evaluates, for the administrative record, a Section 10 (a)(1)(B) permit application in the context of permit issuance criteria found at Section 10 (a)(2)(B) of the Endangered Species Act and 50 CFR Part 17.

Settlement Agreement – Protection plans developed through negotiations with the fishery agencies and Tribes that specify mitigation and compensation measures for the impacts to anadromous fishery resources as a result of project operations. The fish protection agreements for the Wells, Rocky Reach, and Rock Island projects are documented in the 1990 Wells Long-Term Settlement Agreement, the 1994 Fourth Revised Rocky Reach Interim Stipulation (expired), the 1987 Rock Island Settlement Agreement, and the Vernita Bar Agreement. For the purposes of this EIS, signatory parties refers to those agencies, Tribes, and non-governmental organizations that will ultimately sign and abide by the terms of the HCP agreements. As a result, each of the signatory parties will be represented on the HCP Coordinating Committees.

Signatory Parties – For the purposes of this EIS, signatory parties refers to those agencies, Tribes, and non-governmental organizations that will ultimately sign and abide by the terms of the HCP agreements. As a result, each of the signatory parties will be represented on the HCP Coordinating Committees.

Sluice – A spill gate specifically designed to drain water from the surface of the reservoir

Smolt – A juvenile salmon or steelhead migrating to the ocean and undergoing physiological changes to adapt its body from a freshwater to a saltwater environment.

Spawning – The releasing and fertilizing of eggs by fish.

Species –any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature.

Spill – Water passed over a spillway instead of going through turbines to produce electricity. Spill can be forced, when there is no storage capacity and flows exceed turbine capacity, or planned, for example, when water is spilled to enhance juvenile fish passage.

Spillway – The overflow structure of a dam.

State Environmental Policy Act (SEPA) – Chapter 43.21C RCW. Enacted in 1971, it provides the framework for agencies to consider the environmental consequences of a proposal before taking action. It also gives agencies the ability to condition or deny a proposal due to identified likely significant impacts. The Act is implemented though the SEPA Rules, Chapter 197-11 WAC.

Steady Progress – For the purposes of this EIS, steady progress refers to increases in Plan species survival over the long-term. Increases and decreases in survival between years as allowed as long as a demonstrable upward trend exists. In order to assess steady progress, the PUDs shall conduct interim monitoring and evaluation, such as hydroacoustics and assessment of fish passage efficiency, as agreed to by the Coordinating Committee during Phase I.

Steering Committee – Group or panel of individuals representing affected interests or stakeholders in a conservation planning program, the private sector, and the interested public, which may be formed by the appropriate development, land use, and mitigation strategies, and to communicate progress to their larger constituencies. The USFWS and the NMFS representatives may participate to provide information on procedures, statutory requirements, and other technical information.

Storage Reservoir – A reservoir that has space for retaining water from springtime snowmelts. Retained water is released as necessary for multiple uses–power production, fish passage, irrigation, and navigation.

Structural Depression – Valley area formed by geologic faulting.

Subyearlings – Juvenile fish less than 1 year old.

Tailrace – The canal or channel that carries water away from a dam.

Tailwater Elevation – The average or minimum water elevation at the toe of the dam.

Take – Under Section 3(18) of the Endangered Species Act, "…to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct" with respect to Federally listed endangered species of wildlife. Federal regulations provide the same taking prohibitions for threatened wildlife species [50 CFR 17.31(a)].

Threatened Species – Any species designated under the Endangered Species Act that "is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" [Section 3(19) of the Endangered Species Act].

Tool – For the purposes of this EIS, tool means any action, structure, facility or program (on-site only) at the Wells, Rocky Reach, and Rock Island dams that are intended to improve the survival of Plan Species migrating through the dams. Tools do not include fish transportation, drawdowns, dam removal, and non-power operations.

Total Dissolved Gas – Total dissolved gas is the amount of all gases that are in solution (e.g., nitrogen, carbon dioxide, oxygen, etc.). "Supersaturation" occurs when water is aerated to the degree that dissolved gases in the water exceed equilibrium conditions for saturation. High levels of supersaturation are harmful to fish; therefore, water quality standards for total dissolved gas are maximum concentrations.

Tributaries – Smaller streams or rivers that enter larger water bodies. For example, the Wenatchee River is a tributary of the Columbia River and Icicle Creek is a tributary of the Wenatchee River.

Turbidity – A measure of the cloudiness or opaqueness of water. In other words, muddy water has high turbidity and clear water has low turbidity. Turbidity is measured by an instrument that passes a beam of light through a water sample and measures the degree to which the light is scattered by suspended particles.

Turbine – Machinery that converts kinetic energy of a moving fluid, such as falling water, to mechanical or electrical power.

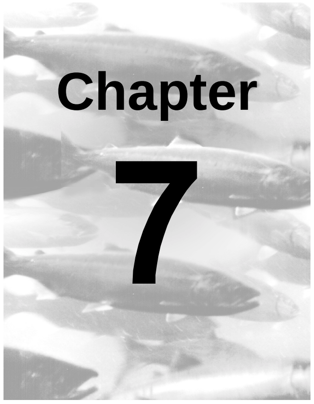
Upper Columbia River – That portion of the Columbia River upstream of Chief Joseph dam.

Upper Columbia River Spring – Run Chinook Salmon Evolutionarily Significant Unit – This ESU contains the only remaining genetic resources of those spring-run chinook salmon that migrated into the upper Columbia River Basin (prior to the construction of Grand Coulee Dam), as well as those spring-run chinook salmon that historically migrated to the Mid-Columbia River region. NMFS also identified six hatchery stocks associated with the Upper Columbia River spring-run ESU: Chiwawa River, Methow River, White River, Twisp River, Chewuch River, and Nason Creek.

Water Quality Standards – Define the minimum requirements to protect beneficial uses of rivers, creeks, lakes, and other water bodies and are required by the federal Clean Water Act for all states to establish and enforce. The current Water Quality Standards for Surface Waters of the State of Washington (Chapter 173-201A of the Washington Administrative Code) designate water bodies as "Class AA" (extraordinary), "Class A" (excellent), or other classes. Each class has numerical and narrative standards to protect general beneficial uses, with Class AA having the most stringent standards. In the future the standards will be changed to identify specific beneficial uses for each water body. Similar to State standards, Tribes administer water quality standards on their lands.

Water rights – Water rights permits are required from the WDOE to withdraw water from rivers, creeks, lakes, or groundwater resources. These permits specify where, when, and how much water may be withdrawn. In many areas of the State, water rights have been over-allocated to the point that there is not enough water to both meet the demands of water rights applicants and sustain water quality and fisheries needs.

Wetlands – Areas that are inundated by surface or groundwater frequently enough to support vegetation that requries saturated or seasonally saturated soil conditions for growth and reroduction. Wetlands generally include mrshes, bogs, peatlands, and similar areas such as river overflows, mudflats, and natural ponds.



Chapter 7 Distribution List

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7 DISTRIBUTION LIST

7.1 FEDERAL AGENCIES

Bonneville Power Administration
Bureau of Indian Affairs
Federal Energy Regulatory Commission
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
Mt. Baker-Snoqualmie National Forest
Office of the Solicitor (USFWS)
Office of General Council, USDA (Forest Service)
Okanogan National Forest
U.S. Army Corps of Engineers, Portland District
U.S. Department of Commerce
U.S. Department of the Interior
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. House of Representatives
U.S. Senate, Chief of Staff
U.S. Senate, Democrat Senator from Washington
U.S. Senate, Republican Senator from Washington
Wenatchee National Forest

7.2 STATE AGENCIES/ ELECTED OFFICIALS

Governor of the State of Washington
Governor's Salmon Recovery Office
Lieutenant Governor of the State of Washington
Oregon State Department of Fish and Wildlife
Oregon Department of Justice
Washington State Attorney General's Office
Washington State Assistant Attorney General
Washington State Department of Ecology
Washington State Department of Fish and Wildlife
Washington State Department of Health
Washington State Department of Natural Resources
Washington State Department of Natural Resources, Commissioner of Public Lands
Washington Environmental Council
Washington State House of Representatives, Technology, Telecommunications and Energy Committee
Washington State House of Representatives, House Majority Leader
Washington State House of Representatives, House Minority Leader
Washington State House of Representatives, Speaker of the House
Washington State House of Representatives, 4th Legislative District
Washington State House of Representatives, 7th Legislative District
Washington State House of Representatives, 10th Legislative District
Washington State House of Representatives, 12th Legislative District
Washington State House of Representatives, 13th Legislative District
Washington State House of Representatives, 16th Legislative District
Washington State House of Representatives, 18th Legislative District
Washington State House of Representatives, 19th Legislative District
Washington State House of Representatives, 20th Legislative District
Washington State House of Representatives, 24th Legislative District
Washington State House of Representatives, 27th Legislative District
Washington State House of Representatives, 32nd Legislative District
Washington State House of Representatives, 34th Legislative District

Washington State House of Representatives, 35th Legislative District
Washington State House of Representatives, 44th Legislative District
Washington State Senator, 3rd Legislative District
Washington State Senator, 5th Legislative District
Washington State Senator, 7th Legislative District
Washington State Senator, 11th Legislative District
Washington State Senator, 12th Legislative District
Washington State Senator, 16th Legislative District
Washington State Senator, 19th Legislative District
Washington State Senator, 20th Legislative District
Washington State Senator, 24th Legislative District
Washington State Senator, 26th Legislative District
Washington State Senator, 31st Legislative District
Washington State Senator, 39th Legislative District
Washington State Senator, 40th Legislative District
Washington State Senator, 45th Legislative District
Washington State Senator, 48th Legislative District

7.3 LOCAL AGENCIES

Chelan County Courthouse
Chelan County Port District
Douglas County Courthouse
Malaga/Colockum Community Council
Mayor of the City of Brewster
Mayor of the City of Bridgeport
Mayor of the City of East Wenatchee
Mayor of the City of Pateros
Mayor of the City of Rock Island
Mayor of the Town of Mansfield
Mayor of the Town of Waterville
Port of Douglas County
Wenatchee Chamber of Commerce

7.4 NATIVE AMERICAN ORGANIZATIONS

Columbia River Inter-Tribal Fish Commission
Confederated Tribes of the Colville Reservation
Confederated Tribes of the Umatilla Reservation
Northwest Indian Fisheries Commission
Yakama Indian Nation

7.5 UTILITIES

Avista Corporation
Chelan Public Utility District
Douglas Public Utility District
PUD No. 1 of Okanogan County
Puget Sound Energy
Portland General Electric
Pacificorp

7.6 ORGANIZATIONS

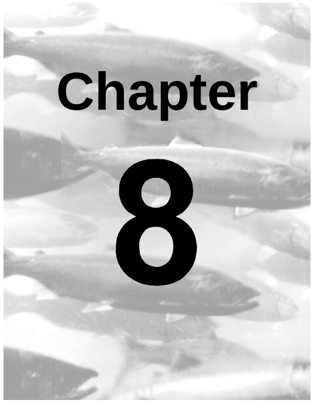
ALCOA
ALCOA Wenatchee Works
American Public Power Association
American Rivers
American Rivers, NW Office
National Audubon Society
National Wildlife Federation
Nature Conservancy of Washington
Quest for Economic Development
Rivers Council of Washington
Sierra Club
Sierra Club Legal Defense Fund
Trout Unlimited
Washington PUD Association
Washington Trout
Wenatchee Downtown Association

7.7 BUSINESSES

American Silicon Technologies
Cockrill & Weaver, P.S.
Colockum Transmission Company
D. Rohr and Associates
Davis, Wright & Tremaine
Duke Engineering
Gordon, Thomas & Honeywell
Jeffers, Danielson, Sonn & Aylward, P.S
Ogden Environmental and Energy
Paine Hamblen
Perkins Coie
Steptoe & Johnson
Thomas H. Nelson Law Offices
Triangle Associates, Inc.
Van Ness Feldman, P.C.
Vanderstoep, Remund & Kelly
Weyerhaeuser Company

7.8 MEDIA

Associated Press
KHQ Television (Spokane)
KIMA Television (Yakima)
KING Television (Seattle)
KIRO Television (Seattle)
KOMO Television (Seattle)
KOZI Radio (Chelan)
KPQ Radio (Wenatchee)
KREM Television (Spokane)
KXLY Television (Spokane)
PR Newswire
Seattle Post-Intelligencer
Tacoma News Tribune
The Columbian
The Herald
The Oregonian
The Seattle Times
The Spokesman-Review
Tri-City Herald
Wenatchee World
Yakima Herald-Republic



Chapter 8

List of Preparers

Chapter

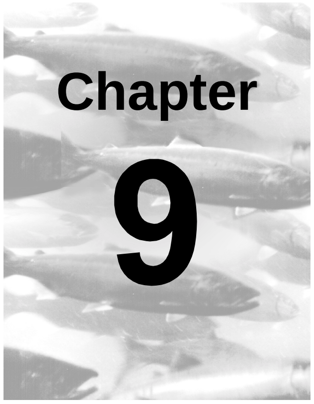
8 LIST OF PREPARERS

The Anadromous Fish Agreements and Habitat Conservation Plans Environmental Impact Statement for the Wells, Rocky Reach, and Rock Island Hydroelectric Projects EIS has been prepared by a team of specialists from a wide range of disciplines. The primary team members are listed below.

NAME	BACKGROUND	EXPERIENCE
Robert Dach Project Manager National Marine Fisheries Service, Portland, Oregon	Bachelor of Arts, Environmental, Populations and Organisms Biology, University of Colorado National Marine Fisheries Service – 1 ½ years Army Corps of Engineers – 7 ½ years Peace Corps, Fisheries – 2 ½ years	Experience includes over three years as an operations biologist at three hydroelectric facilities on the lower Columbia River followed by 4 years of research and development in fish passage systems design and fish behavior and survival.
Pam Gunther Project Manager Parametrix, Inc., Kirkland, Washington	M.A., Biology, California State University B.S., Wildlife (Forest Resources), University of Washington Parametrix – 7 years U.S. Forest Service – 7 years Ebasco Environmental – 2 years EA Engineering – 2 years	Experience includes more than 18 years in the organization and oversight of environmental impact statements, with expertise in long-range planning and management of natural and biological resources.
Bob Sullivan Fisheries Task Leader Parametrix, Inc., Kirkland, Washington	B.S., Fisheries, University of Washington Parametrix – 14 years Quinault Indian Nation – 5 years	Nineteen years of consulting and research experience on fish habitat assessment and enhancement projects which includes work evaluating bypass options, total dissolved gas levels and methods to reduce total dissolved gas at mid-Columbia hydroelectric projects.
Jim Good Water Resources Task Leader Parametrix, Inc., Kirkland, Washington	M.S., Aquatic Ecology, University of Idaho B.S., Forest Management, University of Missouri Parametrix – 12 years	Experience includes 13 years working with water quantity and quality and sediment issues and pertinent regulations. Other related experience includes hydrology and fish habitat assessments in National Forests with Idaho, Washington, Oregon, and Alaska.
Gary Maynard, AICP Land Use Task Leader Parametrix, Inc. Kirkland, Washington	M.A. Candidate, Geography, University of Washington B.A., Geography, University of Washington Parametrix – 11 years City of Bellevue – 3 years	Experience includes 13 years in land use, energy, natural resource, public services, and noise evaluations, analysis, and management.

NAME	BACKGROUND	EXPERIENCE
Marcia Montgomery Cultural Resources Task Leader Historical Research Associates, Seattle, Washington	M.A., History, Washington State University B.A., History, Lewis and Clark College Historical Research Associates – 3 years BOAS, Inc – 2 years National Park Service– 1 year U.S. Forest Service – 1 year	Experience includes 7 years of experience conducting cultural resource assessments of historic buildings, structures, and archaeological sites, and addressing cultural resources according to Section 106 of the Historic Preservation Act, NEPA.
Clay Antieau Plants Task Leader Parametrix, Inc., Kirkland, Washington	Ph.D. Candidate, Horticulture and Botany, University of Washington M.S., Horticulture and Botany, University of Washington B.S., Horticulture, Purdue University Parametrix – 3 years Gaynor Landscape Architects – 3 years Foster Wheeler – 5 years WSU Cooperative Extension – 2 years	Experience includes more then 14 years as a botanist in western Washington specializing in identification and ecology of Pacific Northwest native plants and their habitats. Work includes conducting rare plant and wildlife surveys at hydroelectric projects.
David Mattern, AICP Socioeconomics and Recreation Task Leader Parametrix, Inc., Kirkland, Washington	M.A., Geography, University of Colorado B.S., Geography, University of Washington Parametrix – 16 years	Experience includes more then 16 years in environmental planning with responsibilities in EIS recreation analysis, planning policy evaluations, and land use, visual quality and public service assessments. Work includes research and reports on land use, visual quality and recreation for hydroelectric projects.
Julie Grialou Wildlife Task Leader Parametrix, Inc., Kirkland, Washington	M.S., Wildlife Science, University of Washington B.A., Anthropology, Harvard University Parametrix – 2 years Pacific Forest Trust – 2 years Bureau of Land Management – 2 years	Experience includes more than 7 years of work with threatened and endangered wildlife species, habitat evaluations, populations studies, vegetation surveys, and preparation of associated reports.
Bruce Stoker Geology Task Leader Earth Systems, Monroe, Washington	M.S.E., Civil Engineering, University of Washington M.S., Remote Sensing/Geology, University of Michigan B.S., Geology, Michigan State University Earth Systems – 4 years Ebasco Environmental – 9 years U.S. Forest Service – 1 year	Experience includes 19 years in geologic mapping, sediment transport studies, erosion control plans, hydrologic investigations, engineering review, licensing and permitting, and compliance with regulations related to project design.

NAME	**BACKGROUND**	**EXPERIENCE**
Jill Czarnecki Project Assistant Parametrix, Inc., Kirkland, Washington	B.S., Geology, University of Puget Sound Parametrix – 2 years	Experience includes two years in the organization and preparation of environmental impact statements.
Daryl Wendle Senior Planner Parametrix, Inc., Sumner, Washington	M.A., English, New York University B.A., English, University of Oregon Parametrix – 4 years DKS Associates – 3 years KJS Associates – 3 years Beak, Inc. – 2 years	Experience includes 12 years preparing regional transportation planning and environmental impact studies.
Linda Goetz Cultural Resource Specialist Historical Research Associates, Seattle, Washington	Anthropology Graduate Program (1990-1993), University of Washington B.A., Anthropology, Northwestern University Historical Research Associates – 7 years Dames and Moore – 1 year	Experience includes nine years in archaeological survey, excavation, and analysis. Other related work includes conducting background research, mapping, processing and cataloging archaeological materials, conducting Indian consultation, and writing and editing professional reports.



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